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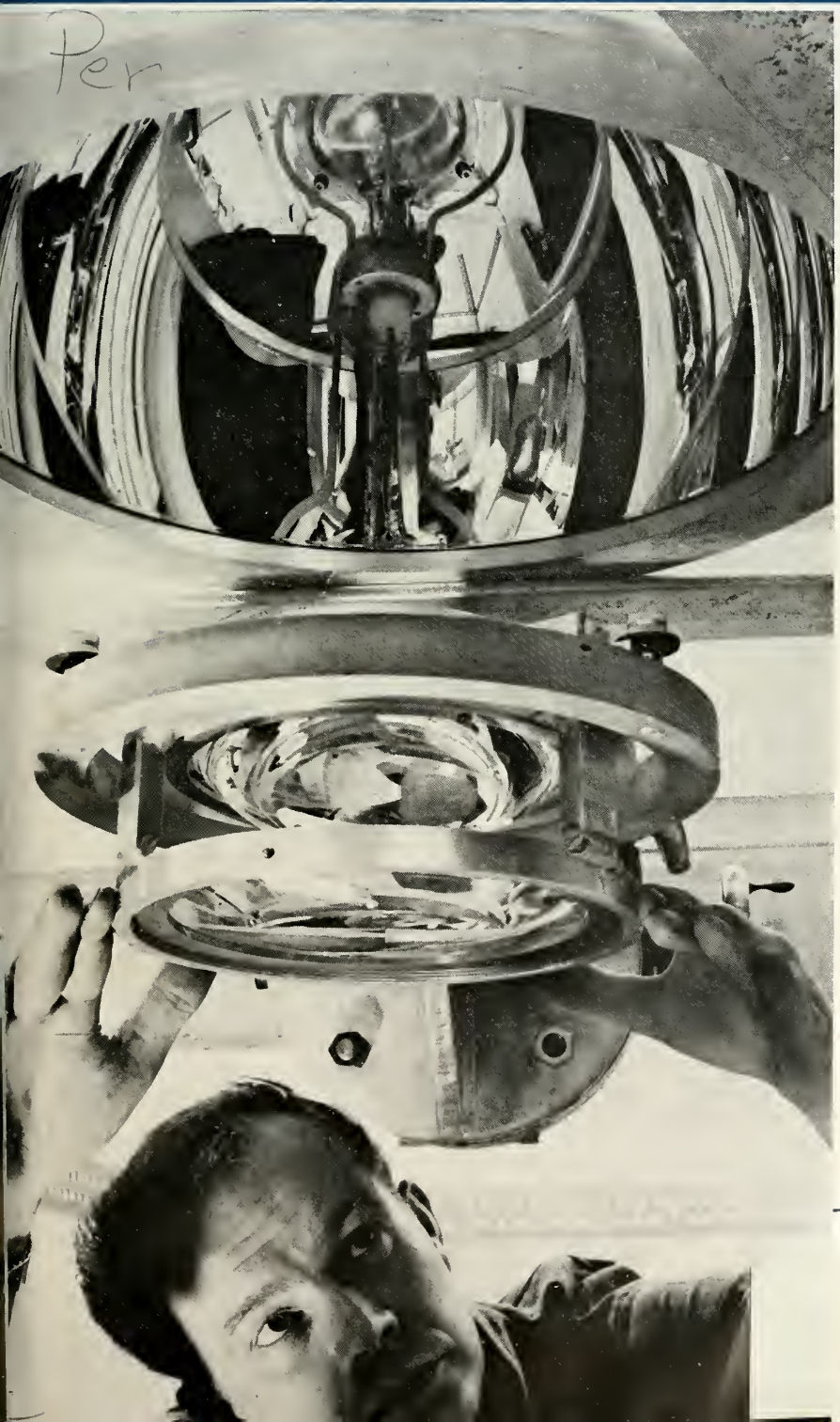
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING



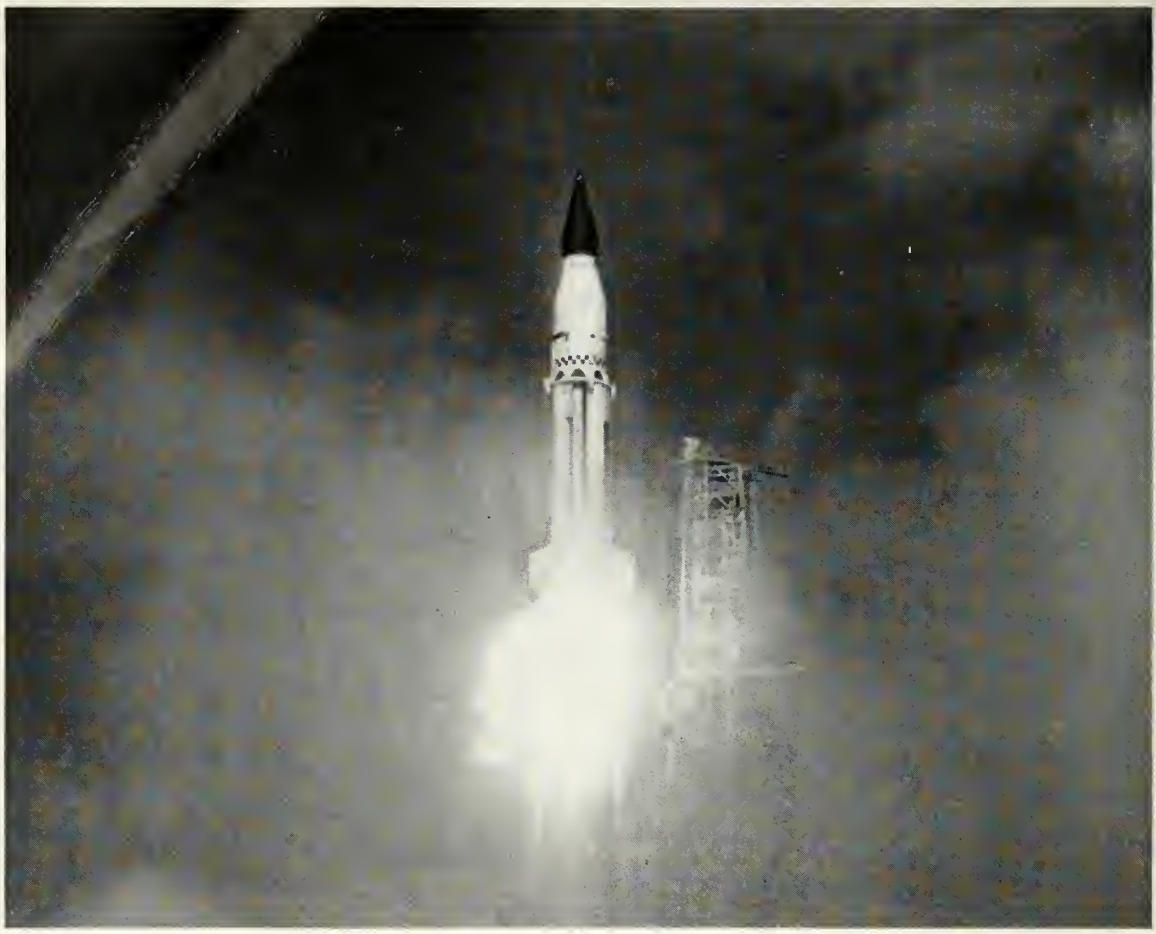
Johnson Tells NASA To Produce Post-Apollo Plans

NASA Split on Ranger Findings

AF Seeks New Missile Tracker

Gaseous-Core Concept Gains

Checking Optical Module In Goddard Simulator



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THE COVER

Technician inspects one of 127 optical modules used in solar simulator part of six-story space environment simulator at NASA's Goddard Space Flight Center. Four Corning Glass Works fused silica lenses in each module focus and collimate light from a mercury-xenon lamp. Final lens acts as a window and seal into chamber's vacuum portion.

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The Purpose:
Optimum effectiveness... USAF weapons inventory

The function of the Service Engineering Division of the Air Force Logistics Command at several locations throughout the United States, is keeping a finger on the pulse of weapons technology, correcting engineering problems as they arise, providing control of design and reliability in procurements, supply and maintenance through engineering applications.

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letters

Combustion Ignition

To the Editor:

Researchers for the "Unknowns of Exploding Bridge Wire" (M/R, March 23, p. 32) may find the following *simplified* explanation of the initiation and spread of ignition useful and time-saving. I have had it under development since 1928, when I conceived a method of preventing, controlling and terminating combustion. They want ignition to start and spread, whereas I am concerned with preventing its starting, controlling its rate of spread and terminating the chain reactions at will. Turn my approach upside down and they can make faster progress.

Combustion is initiated and spread by intermolecular collisions between oxidizing and fuel molecules which are made to collide at ignition velocities. Molecular velocities are directly related to their energy levels and *temperatures*. The amount of energy required to be put into a minimum number of molecules, located in time and space so that they will collide with each other and spread ignition, is usually measured in joules.

The function of an exploding bridge wire is to supply input energy to nearby oxidizing and fuel molecules and thus raise their energy levels and velocities high enough so that they will react and start a combustion chain reaction, thus releasing their available energy. Energy released is predominantly radiant energy, but some is also transferred by collisions between free radicals and relatively stable end-products of combustion. End-products appear to radiate the bulk of the energy which is fed-back, or fed-forward, to raise nearby molecules to their ignition velocities and promote the speed of combustion.

Combustion, as flame or as explosion, occurs most readily in the gas and vapor phases, which facilitate intermolecular collisions in three-dimensional space. A number of researchers agree that ignition of solid-fueled rockets also occurs in the gas phase, after the solids have been heated by input heat to "boil off" fast-moving molecules.

It is a waste of time to try to attribute ignition to any one factor; it is the total energy release transferred, principally, by radiation and collisions, as well as by shock waves, which does the job. Shock waves, by compressing the molecules together, promote energy transfer by collisions, producing instantaneous increases in temperature, and molecular velocities, as the wave advances, and equally rapid drops in temperature after the wave passes, unless ignition occurs at the peak of compression, which occurs readily in sensitive mixtures of fuel and oxidizers.

The importance of pressure in feeding-back energy by intermolecular collisions is illustrated by the fact that many solid fuels for rockets are self-extinguishing when pressure drops because of excessive nozzle area; and when the cores are ejected into air, at atmospheric pressure. The feed-back of energy must be sufficient to maintain boil-off of freely moving molecules in the gas phase and to make them travel at ignition velocities so that fuel-oxidizer collisions will maintain the continuity of ignition, through such intermolecular collisions, and feed-back of released energy. In such self-extinguishment, radiant energy *is* being fed back, but feed-back by transfer-in-contact, between colliding molecules, under high pressure is deficient; it is the total feed-back, by both mechanisms, which is required to keep the chain reactions going and spreading.

Radiant feed-back occurs at the speed of light, but feed-back by contact in collisions appears to resemble more closely the speed of sound, under the existing conditions. When a speeding fuel molecule cannot find an oxidizing molecule to collide with before its temperature and velocity have been reduced by contact-transfers of energy to other types of molecules in intervening collisions, it may be going too slowly to react with an oxidizing molecule when it eventually meets one. The boys who are trying to ignite and spread combustion should avoid it, and be aware of its existence.

Dawson Powell
Patentee of "Fire-Inhibited-Air and Fuels"
Warwick, Rhode Island

Industry Waste

To the Editor:

In reference to your March 16 editorial, I think very little of *Harper's* magazine, but I must admit they hit the nail on the head regarding the exposure of the missile industry and the decadent military.

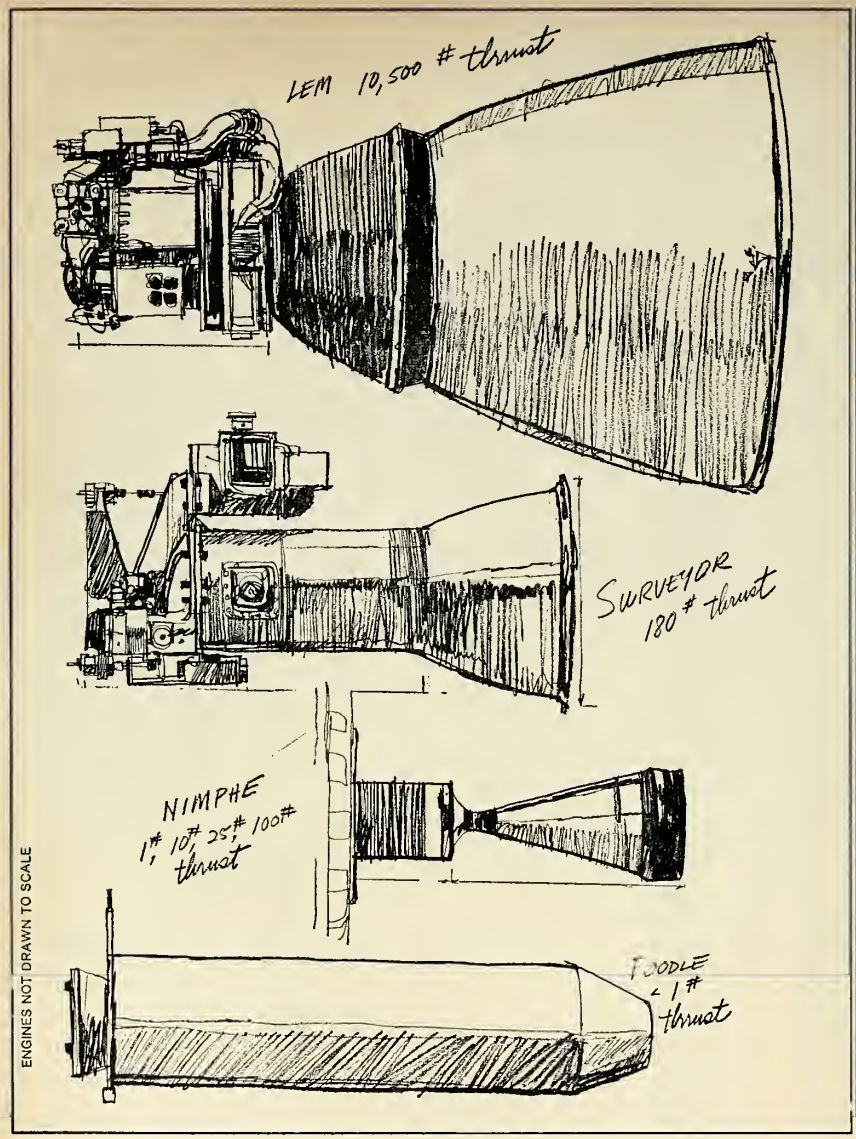
I lived in Washington, D.C., for 35 years, with constant contacts in all branches of the Government. I was a manufacturer's representative and I know the waste and pork-barrel ear marks. This is the price we pay for our way of life. Eighty per cent of everything *Harper's* said was true. You have pointed to the same thing many times. I know, having worked for one of the missile firms for three years in "total darkness." All missile companies waste their talents in duplication, confusion, and do-nothing exercises.

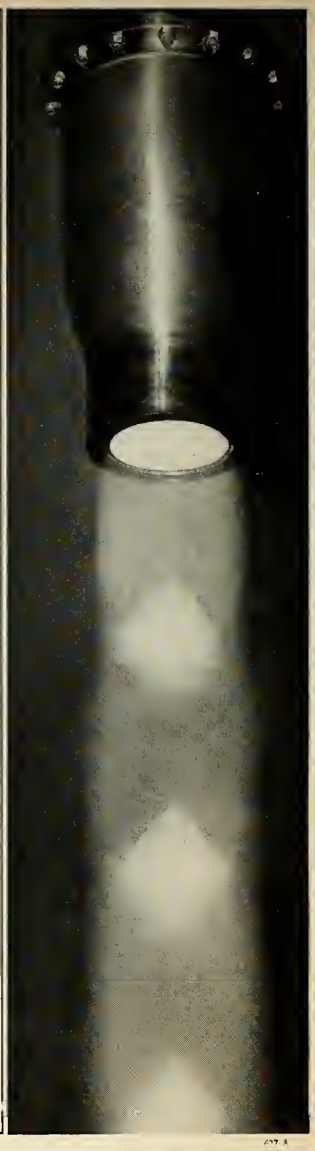
The greatest waste is the hiring of the retired military. They are absolutely unnecessary. Inefficiency is multiplied by the square with each new military man they hire.

Yes, the missile industry is guilty of over-charging, padded personnel waste, false information as to reliability of missiles, inefficiency and nearly anything else you want to charge them with.

I am in private industry now, where you must show a profit to stay in business. This is both challenging and interesting, and American. Not a P.W.A. project, as is the missile industry.

R. D. Stephens
Ogden, Utah





SPECTRUM OF TRW SPACE ENGINES/<1 LB. TO 10,500 LB.

At one end of the thrust scale TRW Space Technology Laboratories is building Poodle, a nuclear engine that uses radioisotopes to heat liquid hydrogen. The higher-thrust NIMPHE, a monopropellant hydrazine engine, has a radioisotope-heated catalyst bed for fast, reproducible starts. Our variable-thrust Surveyor engine is being qualified now for the first soft moon landings in 1965. Of special interest among the larger propulsion devices is the 10,500-pound thrust Apollo LEM engine. We are developing this throttleable descent engine to land men on the moon by 1970. Our many activities in extraterrestrial propulsion and other space and missile projects have created openings for engineers and scientists with experience in: Liquid Engine Design, Development and Test, Combustion and Injection Research and Development, Liquid Engine Feed System Design and Development, Valve Technology, Rocket Engine Test and Development, Theoretical Physics, Systems Engineering, Radar Systems, Experimental Physics, Applied Mathematics, Space Communications, Space Physics, Antennas and Microwaves, Inertial Guidance, Analog Computers, Solid State Physics, Computer Design, Telecommunications, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, and Applied Aerodynamics.

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The Countdown

WASHINGTON

Pershing Range Extension Possible

Substituting another first-stage motor for the present second stage of the Martin *Pershing* could stretch the missile's range from its present 400 miles to 750. DOD officials studying this possibility say the existing guidance system of the mobile Army weapon would not have to be changed to handle the increase, although some work would have to be done on the fuzing and arming system. Further improvements—increased propellant density or new propellants, structural weight savings or a new warhead—could give the U.S. a bargain-basement *MMRBM*.

Heavy Firing Schedule—with Some Ifs

The *Atlas-Agena* pad at Cape Kennedy will be busy in the latter part of this year. *Ranger VII* is due to go in late June. The *Orbiting Geophysical Observatory (OGO)* spacecraft is scheduled for July launching. Following that shot, modification will begin in August for the *Mariner* Mars mission, scheduled for November. If either *Ranger* or *OGO* slips, however, those flights will have to wait until next year. *Mariner* will take priority.

False Economy Stalls OSO Flight Effort

Premature ignition of the *Delta* rocket third stage at Cape Kennedy recently will delay the *Orbiting Solar Observatory (OSO)* program for six months to a year. The problem stems from the lack of a back-up spacecraft—back-ups were dropped after criticism of *OSO* by the General Accounting Office.

Renegotiation Act Gets Tentative New Lease

The House has passed legislation extending the Renegotiation Act for two years—until June, 1966. The measure was approved despite repeated speeches by Republicans claiming that the Renegotiation Board was costing more than it was recovering. Two GOP moves to limit the Act's application to firms doing $5 million or more government business annually—rather than the present $1 million figure—were defeated. The Senate has still to act.

Propulsion Investigation Proceeds

The House Space Committee is continuing its look into the propulsion field. United Technology is the latest company to give the group private briefings.

Gemini II Field Is Narrow

Pilot for the second manned *Gemini* flight apparently will have to be either Gordon Cooper or Scott Carpenter, with the other selected as back-up pilot. Alan Shepard will be incapacitated for six months because of an ear infection. Virgil Grissom and Walter Schirra will be busy training for the first flight and will not be available. Donald Slayton is already disqualified.

Ultraviolet Moon Study Projected

Bids are due at NASA's Manned Spacecraft Center by May 15 on a study of whether ultraviolet spectrograms are feasible from a manned spacecraft in lunar orbit. Early indication is that if the Moon surface is covered with dust it will radiate in all spectra like a perfect black body. The ultraviolet would be used for a study of the deeper structure.

Russian Venus Probe Plans a Mystery

U.S. Space Officials say the mid-course guidance correction of the Soviet spacecraft headed toward Venus was very small. This indicates the probe will come very close to the planet, but the officials still do not know just how close the Russians intend to make it. They apparently doubt that the craft will eject a capsule to land on the planet.

INDUSTRY

Three Firms Win $21 Million in Contracts

NASA has awarded three contracts totalling more than $21 million and chiefly involving propulsion. Marshall Space Flight Center issued the largest—$14.47 million to Pratt & Whitney div. of United Aircraft for development of RL-10 liquid hydrogen engines for *Centaur* and the upper stages of the *Saturn* family. MSFC also awarded Boeing's Aero-Space division $4.74 million for work on the *Saturn V's* S-IC first stage. And Documentation Inc., of Bethesda, Md., received a $1.95 million contract from NASA headquarters for further operation of the space agency's scientific and technical information facility.

AF's Two-Man MOL Under Attack

Validity of the Air Force's *Manned Orbiting Laboratory (MOL)* program calling for a two-man station is being questioned by companies conducting NASA and in-house cost/effectiveness studies on small, medium and large space stations. There's growing feeling that both military and NASA needs would be better met by a station with at least four to six men, which would enable more experimental time by a larger crew as well as a longer stay-time in zero-g environment. Indications are that the Air Force is seriously concerned with extending mission time beyond the announced 30 days.

STL Believed on Hot Nuclear Trail

TRW Space Technology Laboratories are expected shortly to announce a radical development in nuclear propulsion. No details have been disclosed, but it is described by one qualified observer as "one of the hottest things in this field."

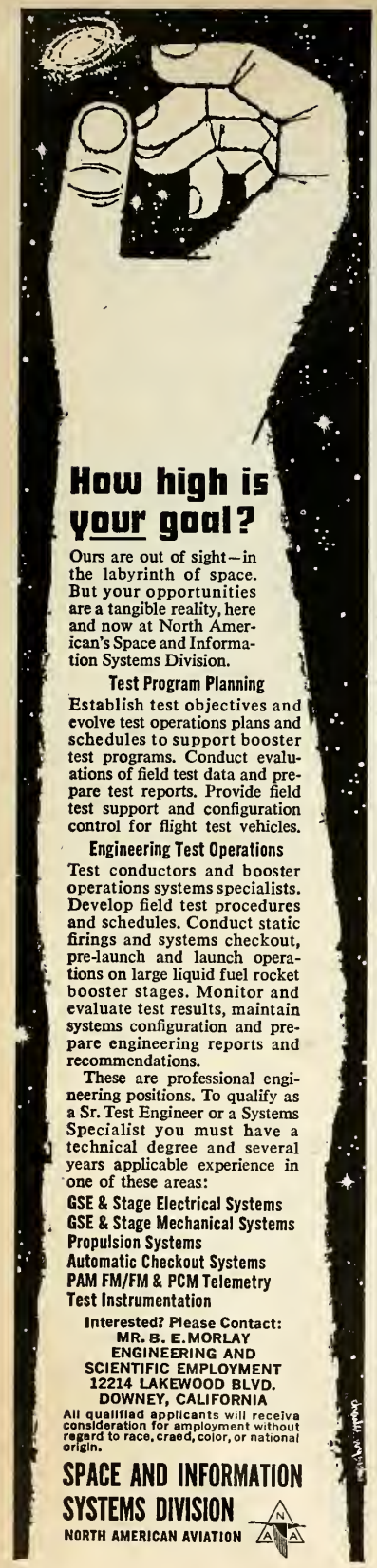
INTERNATIONAL

Germans Sharpen Booster Technology

If models shown at the Hanover Air Show are any indication, West Germany is expending considerable brainpower on space vehicles. Many elaborate booster models are available, some with unique design approaches. Titanium technology is being touted, as well as precision metalworking. One German aerospace firm president looked over a piece of U.S. hardware showing some rough edges and commented: "What a shame—we'd never make it like that."

ELDO Considers Hawk Gyro Adaptation

European Launcher Development Organization (ELDO) may use a modified version of the NATO *Hawk's* spin rate gyroscope made by Teldix. The German company, a jointly owned firm of Telefunken and Bendix, has proposed the component for use in the third stage of the ELDO booster.



The Missile/Space Week

New Propulsion Seen

Gaseous-core nuclear rockets are the "probable next step" in propulsive space power (see p. 26). The spacecraft employing a gaseous-core rocket might be about the size of a Boeing 707 or a DC-8. In its simplest version, it would produce 2,500 seconds specific impulse, a National Aeronautics and Space Council staff member said in Tampa, Fla., late last week.

Charles S. Sheldon II, speaking to the Working Conference on Space Nutrition and Related Waste Problems, foresaw the possibility of a radiator being added to the gaseous-core rocket, thereby raising its specific impulse to 10,000 seconds.

In discussing the nation's space programs, Sheldon also made the following points:

(1) Under favorable circumstances, Mars could be explored initially for only about $5 billion added to the *Apollo* $20-billion price tag.

(2) The Administration wants "continuity" in the funding of succeeding space budgets, not valleys following the peakings of major programs.

(3) In the long run, the "military future in space (will) be built around manned vehicles."

(4) The Space Council is looking with much interest at the capabilities of a cleverly designed chemically fueled rocket using high-energy propellants to give it a total Δv of 60,000 fps. This would give "greater flexibility in opening the launch windows" to the planets.

Six MILA Bidders Picked

NASA has selected six firms to bid on a three-year, $20-million launch support services contract for the Kennedy Space Center at the Merritt Island Launch Area.

A field of 22 firms that submitted proposals was narrowed to Aerojet-General Corp.; American Machine & Foundry Co.; Bendix Corp.; Chrysler Corp.; General Dynamics Corp. and Westinghouse Electric Corp.

Services to be rendered by the successful bidder will entail engineering support, technical shop operations, materials cleaning and testing, converter-compressor facility operation, ordnance storage and checkout, and propellants.

The contract will be a cost-reimbursement type carrying incentive award provisions. It will be awarded for one year with renewal options for the next two years.

About 360 engineers and technicians will be involved during the first year and nearly 700 will be needed before the third year expires.

This will be the fourth and largest contract for MILA. Already awarded are contracts for communications (Radio Corp. of America—Southern Bell), administrative services (Ling-Temco-Vought) and base support services (Trans World Airlines).

Shots of the Week

The Air Force launched two *Minuteman* ICBM's last week, one from Vandenberg AFB, Calif., on April 23; the other, from Cape Kennedy on the 24th. The second shot was thought to be a hybrid version of the *Minuteman* equipped with an experimental payload to test warhead decoys.

- The Air Force on April 23 launched an *Atlas-Agena* rocket toward polar orbit from Vandenberg AFB, Calif., carrying a secret payload. The Air Force would not reveal either the mission of the shot or whether it reached polar orbit.
- A second secret Air Force satellite was launched toward polar orbit from Vandenberg AFB, Calif., on the 24th, this one aboard a *Thor-Agena* vehicle.
- NASA test pilot Air Force Maj. Bob Rushworth flew the *X-15* rocket plane from Edwards AFB, Calif., April 29 in a mission to determine the effect of high-speed shock waves on photography. Rushworth flew the plane to an altitude of 102,000 ft. and a speed of 3,903 mph.

Quasar Defined

The little-known quasi-stellar object, or quasar, considered the most powerful source of energy in the universe, has been defined as a vast collection of hot, electrically charged gas that may or may not have collapsed due to its own sheer mass.

In a paper before the spring meeting of the American Physical Society in Washington, D.C., last week, physicists Dr. Louis Gold and Dr. John W. Moffat of Martin Co.'s Research Institute for Advanced Studies, presented what is purported to be the

first physically consistent explanation of the tremendous energy sources discovered a little over a year ago.

An important consideration in the Gold-Moffat theory of the unidentified objects is a force known as Debye energy.

The nature and significance of the quasars have puzzled scientists since optical telescopes first pinpointed them as sources of radiation as high as 10^{46} ergs/sec., an absolute energy 100 times that of our galaxy. The nine quasars located to date range from 2 billion to 10 billion light years from Earth.

Gold and Moffat dismiss earlier conjectures that quasars were either stars or galaxies, and describe them as envelopes of shielded electrons surrounding a core with a minimum mass of 100 million Suns.

Scientific investigators have hypothesized that the intense radiation given off by the objects is a result of an implosion, or gravitational collapse occurring when normal contraction suddenly reaches a critical point. It could not be explained how the gravitational energy was converted efficiently into radio waves.

Gold and Moffat argue that such conversion, although possible, is not necessary because of the Debye free energy, a special energy in a material which is electrically neutral but includes ions. The scientists emphasized that the Debye energy they refer to is not the same as ordinary electrostatic forces, which they consider negligible in the gas clouds.

Although recognized for more than 40 years, Debye energy is normally so small that it has been considered seriously only in reactions on the atomic level or in calculations of liquid electrolytes. However, Gold and Moffat point out, with objects the size of quasars, Debye free energy becomes an imposing factor.

400 To Attend NASA Review

A detailed review of recent accomplishments in NASA's advanced aeronautical and space research will be held at Langely Research Center, Hampton, Va., May 18-22.

More than 400 management leaders in the aerospace industry, representatives of Congress and government agencies, educators, civic officials and others concerned with NASA activities will attend.

Among research activities to be discussed will be low-speed flight aircraft operating problems, spaceflight simulation, innovations in instrumentation and data handling, specialized computing techniques, launch vehicle

COMMAND PERFORMANCE!



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RADIO CONTROL SET

Command flight control equipment by RS Electronics is setting new reliability standards. Remote control of the Navy's KD2R-5 drone shown here is achieved with RSE's Radio Receiving-Control Set which bears the MIL designation AN/ARW-79.

This set consists of an RSE Command Receiver Model 2624AT, proportional Decoder Model 1301A and Model 1805W Accessory Decoder if required.

These components comprise a single, compact airborne package designed and built for Northrop Corporation under U.S. Navy contract. This equipment combines solid state reliability with the packaging advantages of specially designed printed circuit boards.



Model 2624AT/1301A

Operated in conjunction with an airborne gyro to provide automatic flight stabilization, the unit will also control line-of-sight flights without the gyro. The basic package weighs only 4 lbs. 13 oz. and measures 7⅝" high x 7¼" wide x 5¼" deep.

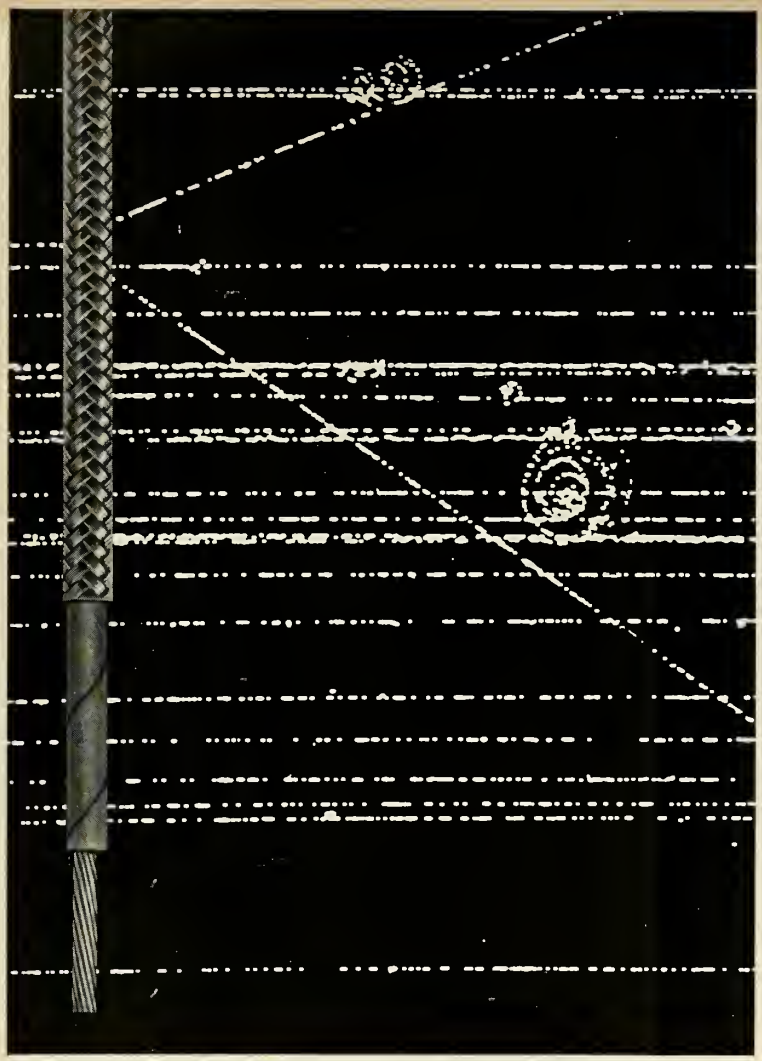
In addition, RS Electronics can provide complete communications links for the remote control of pilotless aircraft and missiles. A typical link would consist of a coder, transmitter, airborne receiver and decoder.

For complete specifications on this Radio Control Set or other RSE equipment to satisfy special requirements, write to:

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and spacecraft dynamics, structures and materials, hypersonic flight and re-entry studies, magnetoplasmadynamics, and space environment investigations.

NASA Continues Accident Probe

A NASA fact-finding committee has recommended that tests be conducted to determine if static electricity caused the accidental ignition of a *Delta* rocket third-stage that killed two men and injured nine others April 14 in the Spin Test Facility at Cape Kennedy.

Three other possible causes of the accident are still being studied, but none appears to be likely.

There were no flood lights on at the time of the accident and the room in which it occured was air conditioned and humidity controlled, making heat seem unlikely as a cause.

Shock appears an improbable cause NASA says, since the motor's propellant is not highly sensitive to jarring and at the time of the accident the motor was stationary.

A third possibility, outside radio signals, is being studied in more detail, but no radio signals were present in the area at the time of the accident, according to the Air Force, which has the radio monitoring responsibility at the Cape.

Avco Building Space Labs

Avco Corp. is investing a million dollars in new space laboratories at its Research and Development Div. in Wilmington, Mass.

Work is scheduled to begin immediately on the seven new facilities, which will be located in existing buildings. The major laboratory, called the "Astrolab," will be a celestial simulator and test range for the division's guidance and control department. It will include a celestial observatory to reflect Sunlight and starlight through the roof to the equipment inside. It will be used for testing components and systems with star trackers, Sun sensors, planet trackers and horizon sensors.

Other facilities will include:

A new planetary entry simulator to simulate both the planetary entry and Earth re-entry heating expected for planetary missions.

A planetary atmosphere antenna facility for experimental work on antenna performance in planetary atmospheres.

A space communications laboratory that will contribute to communications systems for transmitting data over extremely long ranges.

Circle No. 4 on Subscriber Service Card

HONEYWELL

INSTRUMENTATION NEWS

MILITARY EDITION

Number 2-MI

Honeywell Designs Custom Cryostats

POTTSTOWN, Pa. — Cryostats designed by Honeywell's Special Systems Division for the calibration of platinum and germanium cryogenic temperature sensors are now in service at NASA's Huntsville, Ala., facilities in connection with the Saturn space vehicle program.

The self-contained, integrated systems include dewars, precision control equipment, high-accuracy measuring circuits and digital readout equipment. Also in the relay rack-mounted systems are programmers for automatic operation and NBS calibration reference standards.

Calibration is accomplished by inserting test and control sensors and the primary standard into the appropriate cryogen — liquid helium, nitrogen, hydrogen, etc. By controlling the temperature of the cryogen at various levels, defined precisely by the primary standard, calibration data is developed and printed out. Up to six sensors of the same type can be calibrated at one time.

All Honeywell cryostats are custom-designed. Inquiries should include such information as calibration range, sensor type, sensor size, number to be calibrated at one time, accuracy requirements, and typical calibration curves.

WRITE FOR FULL INFORMATION

New Portable Lab Recorder Measures 100μv to 100v

PHILADELPHIA—Honeywell's Philadelphia Division recently introduced an all new portable lab recorder capable of measuring voltages from 100 microvolts full scale to 100 volts dc full scale without auxiliary equipment.

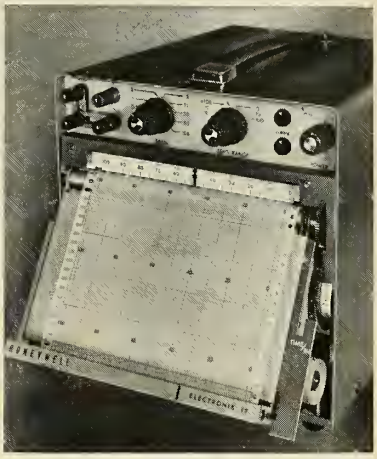
This new instrument, the *ElectroniK 19* strip chart recorder, combines a wide measuring range with a variety of features which its designers say makes it one of the most versatile recorders available for laboratory or test applications.

In introducing the new instrument, Honeywell Market Manager William Forsyth emphasized that the *ElectroniK 19* recorder has been designed specifically to meet the needs of the military test market.

"For example," he explained, "the wide selection range of the new instrument makes it possible to measure with one recorder signals which usually require several units or auxiliaries such as preamplifiers or attenuators."

The *ElectroniK 19* lab recorder has a unique tilting platen that pulls up from a vertical position and locks at either a 30° or 45° angle.

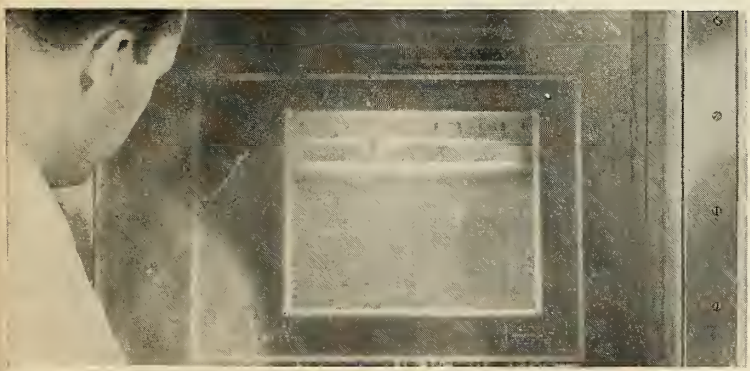
"There also is a tear-off bar for fast, easy removal of selected records," Forsyth pointed out. "When you add the completely removable chart transport and quick thumb-wheel selection of 10 chart speeds from one inch in 10 minutes to an inch a second, you can appreciate how we have engineered this instrument for the user."



ELECTRONIK 19 **PORTABLE LAB RECORDER has a range from 100 microvolts to 100 volts full-scale, weighs less than 20 pounds, occupies less than one square foot.**

Forsyth also noted that the new recorder's potentiometric measuring circuit provides ±0.25 per cent full-scale accuracy and up to 100 per cent of full-scale zero displacement to expand the effective range when the signal goes off scale. Other standard features include high-performance, null-balance servo with frequency response down less than 1% full scale at 5 cps from 10% peak-to-peak amplitude, along with wide measuring capacity from low-impedance detectors to high-impedance bridges.

WRITE FOR FULL INFORMATION



NEW ***ELECTRONIK 16*** Strip Chart Potentiometer is subjected to temperature and humidity extremes in a Honeywell evaluation laboratory environmental chamber. An intensive evaluation program for the ***ElectroniK 16*** line assures quality, overall reliability and repeatable performance capability under a wide range of operating conditions.

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Circle No. 5 on Subscriber Service Card

Orders report by Sept. 1 . . .

LBJ Wants Post-Apollo Plans

White House request indicates space program's budgetary restrictions may be lifted; FY '66 Voyager funding promising

by Hal Taylor

PRESIDENT JOHNSON has ordered NASA to submit a comprehensive report by Sept. 1 on all possible post-*Apollo* programs.

The order apparently means the White House is getting ready to take the lid off the no-new-starts budgetary holds currently restricting the U.S. space program. Best bets among the new projects are the Lunar Logistics System for post-*Apollo* exploration and the *Voyager* unmanned interplanetary craft.

Initial funding for some of the projects is expected to be included in the budget to be submitted to Congress next January.

A White House spokesman confirmed that the report had been requested, but he refused to discuss it in any detail. It was learned, however, that NASA Administrator James E. Webb recently briefed Manned Spacecraft Center officials on the report. He told the senior scientists' symposium that some funding for new projects can be expected in FY '66.

● **Gemini inputs wanted**—Webb said the agency would like to wait until some of the results of the early manned *Gemini* flights are in before making a decision on some post-*Apollo* projects.

"We have the technical capacity to undertake far more than the nation is willing or can afford to undertake. It is now time to consider what comes after *Apollo*," Webb declared. He said some of the proposed ideas may not get the first approval until several *Apollo* missions are flown in 1968-69.

Webb did not say which of several projects would have preference in his report. He did indicate that the agency intends to rely heavily on the *Apollo* spacecraft and various mission modules for new exploration projects both before and after the first manned lunar landing.

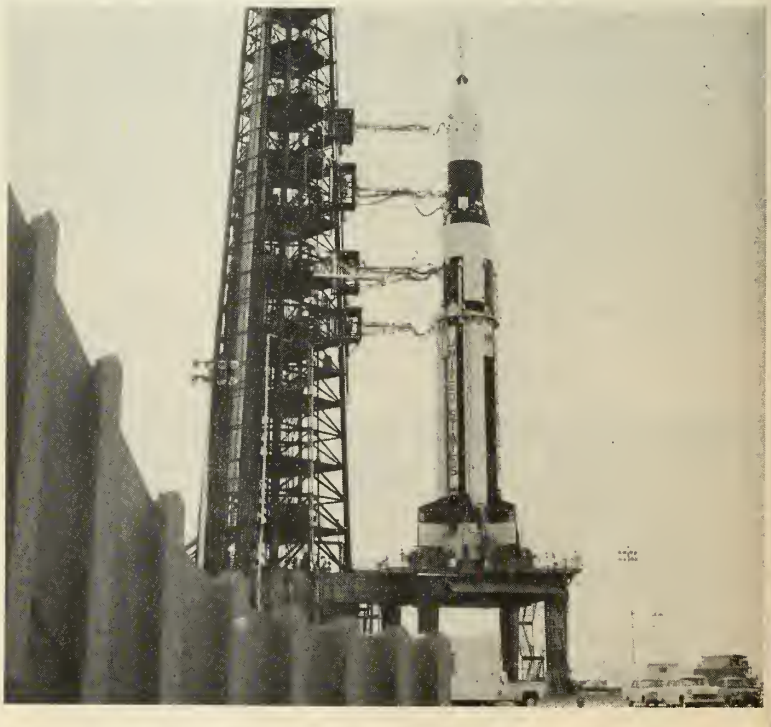
● **Most promising systems**—Dr. Hugh L. Dryden, deputy administrator, in Boston for NASA's Fourth Annual Conference on Peaceful Uses of Outer Space, told MISSILES AND ROCKETS that a logistics system for post-*Apollo* lunar exploration and the *Voyager* spacecraft now appear to be in the best position for early funding.

Dryden said that the agency probably won't move ahead with the *Extended Apollo* spacecraft—which could orbit the Earth for up to 120 days—until it completes some of the current studies of the concept.

He added that as far as future manned space stations are concerned, NASA will probably wait until the Air Force's *Manned Orbiting Laboratory (MOL)* gets off the ground. The NASA official said that the preliminary report will be in the President's hands long before Sept. 1, but a complete statement on future plans will take several months.

No one at the White House or the Boston conference—attended by some 700 persons—would comment on the purpose of the President's request. Some did point out that the decision to go ahead with post-*Apollo* programs will be a national decision, and that the President simply wants NASA's thinking on the future course of the space program.

It is expected that funding of any new projects will boost the space agency's budget for next year above this year's level of $5.304 billion. Currently funded programs alone will keep it at the FY '65 level. ■



SA-6 Configuration Mated at Cape

FIRST PHOTO of mated boilerplate Apollo Service Module and Saturn booster that will be used in SA-6 launch, now scheduled for late this month. Shot will take place from Launch Complex 37 at Cape Kennedy, and Service Module will go into Earth orbit.

Titan III Contract Highly Advanced

Launch vehicle program, now on schedule and within funding, can yield Martin 50% dividend; PERT events set by quarters

by James Trainor

A UNIQUE Cost-Plus-Incentive-Fee (CPIF) contract, being used by the Air Force for the *Titan III* Standardized Space Launch Vehicle, imposes strict penalties on the prime contractor for deviating from the target cost, schedule or flight-performance objectives. At the same time, the Martin Company could earn as much as 50% increase in fee, as a percentage of the target cost, to reward it for maximum performance in these three areas.

An overrun on the $808-million program which exceeds 35% of the target cost, for instance, would cost the company a reduction in fee. The 50% increase in fee would result only if the company achieved all the schedule and performance objectives at 70% of the program target cost.

Although the severest penalties are allocated to cost control of the *Titan III*, the company can actually underrun the contract and still lose as much as 30% of its fee. Quality of the system and timeliness of delivery are just as important as the cost. For example, if the schedule and flight objectives are met, the contractor could overrun as much as 8% of the target cost and still earn a 30% increase in fee.

Titan III, at the moment, is "on schedule and within the planned funding," according to DOD officials.

● **Schedule milestones**—As on all major DOD projects, PERT (Program Evaluation and Review Technique) is used to control the schedule. The *Titan III* program uses some 2,200 PERT events on the control network. "This level of detail," Robert B. Demoret, program manager of *Titan III* applications and growth at the Martin-Denver Div., told the House Manned Space Flight Subcommittee, "is adequate to maintain comprehensive knowledge on the schedule maintenance of the complete program while keeping the level of detail suitable to providing weekly reviews for management."

Out of the total control network, approximately 330 events have been identified as incentive PERT events. These are established by quarter and are defined exactly as to the quantity and quality of work to be accomplished by a specific completion date. Associated strictly with fee penalties, each quarter carries the same total impact on the incentive fee. While the contractor stands to lose for each event which is missed, those which are achieved do not affect fee. Events are assigned by quarter to prevent penalties being carried over from previous quarters' slippages. Should government equipment arrive late, no fee penalties are assessed for PERT events missed as a result.

Another schedule incentive is the identification of 20 program milestones —delivery of the 17 flight vehicles and three complete sets of aerospace ground equipment vans—under the terms of the original contract. Accomplishing these milestones on schedule can offset penalties incurred as a result of missed PERT events. "The objective of this approach," Demoret explains, "is to reward sound management for overcoming early program difficulties through appropriate recovery action to maintain major program items on schedule."

In practice, this would mean that, although the contractor had missed PERT events during the development, no loss in fee would result if all the milestones were met on schedule. If 80% of the milestones were met on schedule, this would offset 80% of the fee lost by missing PERT events.

While the PERT fee penalties provide an incentive for the contractor from the initiation of the program, the milestone system allows fee to be recovered through effective and skillful management which results in timely end-item delivery.

As of the end of February, the *Titan III* program was in the fifth quarter, with 173 PERT incentive events having been reached. Of these, 155 had been met on schedule, 16 had been missed and 12 were awaiting final determination.

● **Flight incentives**—Coupled with the cost and schedule incentives, there are two types of flight-performance awards. The first is a fixed-value award for the "complete success" of the first Configuration A flight vehicle and the first Configuration C. "Complete success in these cases being defined as accomplishing the flight by the contract schedule date and having the transtage burnout occur in a target zone that is approximately the size of Soldiers Field in Chicago," Demoret explained.

Any failures, regardless of whether Martin or one of its associate contractors is at fault, result in the forfeit of the achievement award. The purpose of these achievement awards is to provide incentive for the earliest possible successful demonstration of the program in order to provide the basis for operational planning by the Air Force.

The other type of flight incentive is based on a point total. Each flight is divided into six reference phases: countdown, completion of the solid rockets' burn, staging of the solids, completion of burning of Stage I, Stage II and the transtage portions of the core vehicle. Different point values are assigned to each of these six phases for each flight—with 100 points being the maximum for a single flight and 1,500 the maximum for the entire flight-test program.

Points are distributed so that it is progressively harder to accumulate points as the test program continues; a high degree of success must be achieved not only to improve on the target fee but merely to maintain the target fee level. For example, on the second flight of the *Titan III-C* 70 points can be achieved through the first three phases; on the final flight test only 20 points can be gained through the first five phases.

Until a total of 600 points has been achieved, a fixed loss of fee is assessed against the contractor; from 600-900, the amount of fee loss decreases to zero; from 900-1,100 points, there is no change; from 1,100-1,400, fee increases to a maximum. ■

Haggle Develops Over Ranger Failure

House Oversight Subcommittee hearings disclose rift about Webb's letter to Congress regarding malfunctions

by Heather M. David

TOP MANAGEMENT at NASA appears to be split over a letter written by Administrator James E. Webb to the Congressional space committees outlining findings of the Hilburn committee on the failure of *Ranger VI*.

Some disagreement over the conclusions themselves was evident at hearings held by the House Space Committee's subcommittee on NASA oversight (M/R April 13, p. 15), chaired by Rep. Joseph Karth (D-Minn.).

Dr. Homer E. Newell, associate administrator for space sciences and applications, told the group "the Office of Space Sciences and Applications felt that one of the difficulties with the letter . . . was that it was incomplete and in what it left unsaid may have left a wrong impression." He added that "it is not correct to conclude from Mr. Webb's letter that the *Rangers* were not thoroughly and rigorously tested—they were."

Dr. Hugh L. Dryden, deputy administrator, said in another letter to the space committee that the Hilburn report was "not a definitive agency position." Oran W. Nicks, director of lunar and planetary programs at NASA headquarters, took issue with several conclusions of the Hilburn committee mentioned in the letter.

Karth pointed out that it was the Webb letter that made it necessary for the space committee to hold the investigation. The NASA administrator is scheduled to testify this week.

• **New contract**—NASA has acquired very direct control over programs performed by California Institute of Technology's Jet Propulsion Laboratory, director of the *Ranger* program, under a new contract which has already been initialed by JPL.

Dr. William H. Pickering, JPL chief, said that although the new terms will give NASA "unilateral tasking," he hoped that in practice the working arrangement would be more mutual. The new contract also gives NASA control over personnel in management positions in the program.

Pickering termed "serious" the disagreement between top NASA officials and JPL over the role of the lab. He indicated that NASA felt the lab should be conducted like an industrial organization or one of NASA's centers, while he believed the answer lies in a third type of management.

The feeling was expressed several times during the hearings that personality clashes among top management in both agencies had contributed to difficulties in the *Ranger* program. Asked about this directly, Pickering told the committee he would rather not answer.

• **Rush job?**—Subcommittee members indicated some belief that perhaps an overly rigid schedule was responsible for the *Ranger* failures. All witnesses said that, in general, most of the technical decisions would have been made the same way in spite of the time element. But Pickering admitted that if he had known in October, 1962, that the Block IV and V spacecraft were going to be cancelled and he had only four spacecraft left, he might have postponed the *Ranger VI* launch for a year and a half—instead of one year—to reevaluate the program. He added, however, that during the year's deferral a great many management and engineering changes were made in the program in response to the Kelley report. The latter resulted from a previous NASA investigation.

Ranger Flight	Date Launched	Remarks
I	23 Aug 1961	No Agena second burn
II	18 Nov 1961	Agena guidance failure
III	26 Jan 1962	Excessive launch velocity
IV	23 April 1962	Good launch, Spacecraft failed
V	18 Oct 1962	Good launch, Spacecraft failed
VI	30 Jan 1964	Good launch, Good spacecraft bus, T.V. experiment failed

• **Commonality**—Committee members asked whether the fact that JPL had entered the *Ranger* and *Mariner* programs with the idea of developing a common spacecraft suitable for all lunar and planetary missions might not have compromised *Ranger* design.

Pickering said that the sterilization requirement imposed for the planetary missions was the only "commonality" demand found to have been detrimental to the *Ranger* spacecraft in some of the earlier missions. This procedure was dropped after the failure of *Ranger V*.

• **What NASA has done**—A number of specific design and procedure changes have been made since the Hilburn report on *Ranger VI*, the committee was told. The following will be incorporated in the *Ranger VII* slated for launch during the lunar "window" in late June:

—The TV turn-on circuitry is being modified to provide a positive lock-out of the turn-on signal until after spacecraft separation from the launch vehicle. The circuitry is being desensitized, the four-step switch eliminated, and fault protection is being provided between the several turn on signals.

—All connectors are being potted or sleeved, and additional insulation coating material on all potentially exposed wires and terminals inside the case boxes is being provided to further reduce possibility of shorting.

—Several TV control circuitry leads from the umbilical connector are being removed.

—Telemetry coverage is being modified so that TV measurements will automatically come on whenever the TV system is turned on.

—TV thermal-balance paint patterns are being modified as indicated by the *Ranger VI* flight results.

—NASA will closely monitor the *Ranger* test program at JPL and the spacecraft will not be shipped until NASA has reviewed all test results.

Nicks added that there were a number of recommendations in the Hilburn report in which "it is generally agreed that the modification would be desirable if properly evaluated and qualified."

—A properly applied and qualified relay would be a better control component than the Silicon Controlled Rectifier (SCR). JPL and RCA are studying substitutes, but no acceptable replacement has been found. "Since all present evidence indicates that the SCR is an acceptable component, the SCR is being carried in the design."

—Cleaning of cabeling to remove unnecessary connections and to provide a positive ground system to extent practicable. Several changes have been made, but "there has been no evidence of difficulty in this area and a redesigned cabel harness would require considerable lead-time and program delays that do not appear warranted."

—The umbilical connector on the *Agena* adapter should be reversed. This has been discussed, but will not be changed at this time. "Analysis indicates that these connectors have never caused a problem."

—Full-power TV tests after the spacecraft has been installed in the *Agena* shroud would be desirable.

The lunar and planetary program director added that certain recommendations of the Hilburn board "have not been entirely resolved" by OSSA and JPL:

—Environmental tests, vibration and thermal vacuum should be run with no or few ground monitor wires. Because *Ranger VI* was tested simulating the launch phase in a clean configuration under ambient conditions, "it is felt that the use of cables during other portions of the test program did not in fact mask evidence related to the flight failure." *Ranger VII* will have two complete systems tests under ambient conditions with no cables.

—Microscopic inspection should not be performed after spacecraft environmental tests. "It is a matter of engineering judgment or philosophy as to whether this inspection does more harm than good." *Ranger VII* has already had this treatment.

—Additional venting of the TV component boxes is required to insure against damage of the equipment during the depressurization period of the ascent trajectory. This has been thoroughly reviewed, reconfirming that the venting was adequate, and "therefore no further modifications are planned." ■

Packaging is a problem . . .

Mauler Feasibility Study Tempo Is Quickening

Army Missile Command to oversee progressively more difficult systems tests at White Sands, China Lake

FEASIBILITY VALIDATION of the *Mauler* air defense system is just now moving into high gear, according to Army officials. The validation program is designed to demonstrate to Army and Defense Dept. decision makers the capability of the mobile battlefield air defense system.

Right now "we don't know if anything is wrong with *Mauler,*" an Army official told MISSILES AND ROCKETS. The troubles may be a simple matter to fix or they may be a fundamental defect.

When asked how the program could be four years in development and still the Army didn't know if there was a "fundamental defect" in the system, the officer noted that *Mauler* is an "exceedingly ambitious" program—particularly in packaging the system on one vehicle.

He also noted that on the basis of successful early R&D firings, "calculated risks" had been taken in the test program. It was not until last summer that the Army became aware the system was in major trouble.

● **Studies trigger reorientation**—Last fall, several groups studied the system—including an in-house Army Materiel Command committee headed by Brig. Gen. C. W. Eifler, AMC Deputy for Land Combat systems. As a result of this and other studies, the *Mauler* program was re-oriented and placed in the Engineering Development category (under development but not approved for deployment). This was the genesis of the feasibility validation program being conducted by the Army Missile Command.

Last Dec. 8, the Army placed a letter contract with the prime contractor, General Dynamics/Pomona, for the validation program. A similar contract was awarded to the deHavilland Div. of the Canadian Commercial Corp. for validation of the infrared acquisition unit in the missile. (This IR seeker provides terminal guidance to the missile after initial acquisition and tracking of the target by the pod-mounted radars.) Both letter contracts were to have expired last month but are expected to be extended through the summer.

The *Mauler* concept packages all the acquistion, tracking and fire-unit equipment in one pod, which is then mounted on a tracked vehicle. This ambitious packaging concept, Army officials feel, is the cause of the troubles in the system. The compact size means that space and the heat generated by the radars and other electronic components cause the primary problems.

So far in the validation program, no major problems have been encountered. In fact, as a result of advances in the state of the art since the initial design in 1958, a redesigned computer has been installed in the system.

● **Difficult test program**—Under the validation program, progressively more difficult tests are being made on the system. Design is conducted at the General Dynamics and subcontractor plants while tests are to be conducted at China Lake, Calif., and White Sands Missile Range, N.M. Included in the test program are closed-loop system demonstrations, involving simulation of missile guidance by flying the missile in an airplane with missile control being exercised by the ground unit.

Army officials expect to have "a good evaluation as to whether we should continue with an operational system" by this fall. By February or March of 1965, *Mauler* development is expected to be resumed. Army officials are confident that *Mauler* will prove to be technically sound.

If development is resumed in calendar 1965, it will be the latter part of FY '67 or early FY '68 before the system can be fielded. Meanwhile the Army is not authorized to spend money for production planning or pre-production tooling. Also, development is oriented to meeting minimum system objectives with improvements to meet ultimate requirements postponed for a product improvement program. ■

AEC commissioner reveals . . .

Pluto Nuclear Ramjet Project To Be Dropped

Ramey attacks mission requirement system, scores Defense Dept. for failure to provide adequate funds

A TOP administration official, in an attack on Government practices that are hamstringing the Atomic Energy Commission research and development programs, has revealed that the Project Pluto nuclear ramjet program will be cancelled.

James E. Ramey, AEC commissioner, tied the project's demise to the theory that there must be a "requirement" for a program before it can move to the flight- or ground-test phase.

The system, he declared, results in higher costs, delays and other problems that hold back the AEC program.

"Follow-on requirements, despite successful progress of the reactor technology, have not been forthcoming for the Pluto nuclear ramjet project," Ramey said. As a result, "this very successful reactor technology will be phased out in the next year because of lack of adequate support by the user agency."

The Joint (Congressional) Committee on Atomic Energy had warned both AEC and the Defense Dept. that Pluto might be cancelled if the Tory II-C reactor was not flight-tested "within the next year" (M/R, April 27, p. 18).

● **DOD wouldn't fund**—While the AEC official did not say so, the user agency in this case is the Defense Dept. The statement marked the first public declaration that DOD would not fund flight tests of the program. It apparently marks the end of an "on again-off again" situation in which the Air Force and DOD officials continued to praise the promise of the Pluto technology without ever committing funds to prove the program's feasibility.

Pluto, according to Ramey, is only one of several AEC programs on the cutback casualty list because of what he termed the "requirements merry-go-round."

"Requirements previously stated for three SNAP efforts have been cancelled by prospective users. These are the SNAP-2, -4 and -10A. In addition, flight test plans have been suspended for the SNAP-8 and the *Rover* Nuclear Rocket Program."

Ramey blamed the diminishing number of AEC space projects on the requirements system under which the user agency (either NASA or DOD) had to express firm missions and a firm requirement for a device or component in that mission to permit a developer to move ahead in the R&D area.

The system first was used by the government in production of off-the-shelf items and in fixed-price contracts.

Ramey declared, however, that "unfortunately, under pressure of tight budget and program reviews, the requirements gimmick has become a device for crippling important development projects before they have an opportunity to demonstrate their worth to this nation."

He said that the situation is so out of control that the system has been refined to the stage where there must be a virtual requirement for the development of even a prototype device.

"In atomic energy work," he said, "we would be pleased to be confined initially to the development of prototypes. But we are finding that even prototype or development requirements are being cut back because of an alleged lack of mission."

● **Proposes new system**—To replace the requirements system in R&D programs, Ramey proposed that the government should establish the principle that developers should carry promising developments through the demonstration stage, including flight test where aerospace activities are involved.

"This approach," he said, "provides a potential user with a clear-cut basis on which to make an intelligent decision with respect to specific missions. Meaningful cost analyses are made possible through the practical demonstration of technology, and the elimination of stop-and-go project management can cut waste in expensive technology."

In research and development, more attention should be paid to the broad concept of "potential missions" rather than specific requirements or missions. "No one would want to embark on a development which had no apparent future use; although as I have pointed out, once a device is developed, people see uses which no one could ever have conceived of originally," said Ramey.

Initially, new technology should be directed toward a range of applications rather than toward a specific mission with a specified time scale, which is likely to change and may not be representative of the user's principal needs in that area, Ramey said.

At the same time, efforts should not be proliferated in the early stages among a large family of varied types. The technical effort becomes diffused, and the cost of correcting early problems is at times duplicated. Once a practical demonstration occurs, then a family of applications can be developed which are better adapted to the needs of the user, the commissioner said.

● **Development to prototype**—Ramey suggested each development project should have an "objective" rather than a requirement. The objective should normally be stated in terms of achieving succesful prototype tests in the appropriate environment.

Projects, once undertaken, Ramey urged, should be carefully staffed and vigorously managed. Line responsibility should be clearly established under a project manager armed with sufficient authority to move ahead without being overwhelmed by red tape and endless project reviews by advisory groups and assorted committees. Continuity of key personnel must also be assured.

"In seeking greater freedom to move ahead with important projects which have much to offer the future of this country, we must also demonstrate our will to be very selective in choosing them, and to be very forthright in cutting back or cancelling those that get on the sick list," Ramey continued.

"Budget requests cannot afford to be burdened with moneys for projects which become stalled and can no longer achieve their objectives. Every dollar must be channeled into those projects which are moving forward satisfactorily or into new projects in which we have full confidence of ultimate success." ■

Ames Scientists Advocate Single Earth-Launch Manned Mars Mission

Nova-type vehicles and nuclear propulsion systems, combined with atmospheric braking, might cut trip time to 420 days

NEW YORK—Development of *Nova*-class launch vehicles and spaceborne nuclear propulsion systems, combined with extensive use of atmospheric braking by a spacecraft operating in a Mars orbital rendezvous (MOR) mode, would allow a manned Mars expedition to be carried out with a single launch from the Earth's surface, according to NASA scientists from the Ames Research Center.

The combination, they claim, eliminates the requirement for costly Earth orbital assembly techniques and does away with severe launch-window problems associated with Mars launch holds in Earth orbit.

Use of aerodynamic braking rather than all-propulsive braking at Mars arrival and Earth return cuts the total velocity requirements for the entire manned Mars mission to between 30,000 and 40,000 fps, a reduction of some 50% from the all-propulsive case.

The report was delivered here last week at the Society of Automotive Engineers' Air Transport and Space Meeting.

The round-trip time for minimum weight is also reduced with increasing usage of atmospheric braking. The essentially all-propulsive (nuclear) mode has an optimum trip time of about 510 days. With full atmospheric braking at Earth, the optimal trip times are near 450 days for both chemical and nuclear systems. Use of this braking at Mars will further reduce time to about 420 days.

● **Nuclear propulsion advantages**—In general, the Ames study states that the chemically propelled vehicles are about three times as heavy as those using nuclear propulsion. For chemical propulsion systems, minimum weight in Earth orbit is about 3 million lbs. to accomplish the MOR mode with atmospheric braking at Earth only.

Using this braking at both Earth and Mars cuts weight by 50% to about 1.5 million lbs. This weight is about equal to the all-propulsive nuclear mode.

In the nuclear system, weight in orbit is reduced 40% by substituting atmospheric braking at Earth and another 25% at Mars. These savings, however, as the Ames scientists point out, depend on the ability to advance entry technology to allow 72,000 fps speeds, about twice those of *Apollo* re-entry.

The ability to significantly drop these Earth-orbit weights using nuclear propulsion for the spacecraft rather than chemical, and atmospheric braking rather than propulsive, would probably put a single launch system within the 1-million-lb. Earth-orbit payload capability of a single *Nova* vehicle, and within perhaps a three-launch capability with the 250,000-lb. Earth-orbital range of the *Saturn V*.

Decision on the type of braking used also has an important effect on the choice of Mars launch dates.

Though the *Nova* nuclear spacecraft propulsion route may be optimum, the scientists also outlined an array of launch possibilities using *Saturn V* and *Nova* with either chemical or nuclear spacecraft propulsion, and either atmospheric or propulsive braking at Earth and Mars.

The Ames study, according to the report, treats in considerable detail a somewhat broader range of missions than have been previously studied by NASA's Lewis Research Center and the Marshall Space Flight Center, the latter through such industry primes as Lockheed, General Dynamics/Astronautics and Philco's Aeronutronic Div.

While the study comes up with MOR as the most likely approach, the scientists stress that studies of still greater detail must be made, investigating effects of emergency or abort requirements in particular.

● **MOR spacecraft**—Discussing the spacecraft for an MOR approach, the scientists envisioned a nuclear-propelled craft with a crew of 10, seven of whom would descend to the Mars surface in an excursion module. Three men remaining in the mission module in Mars orbit are the minimum required for safely returning to Earth in the event the EM were lost.

The mission module discussed provides about 700 cu. ft. of free space per crewman. It also includes a centrifuge for artificial gravity that has 100-ft. telescoping arms and produces 1/6 g at 2¼ rpm.

The Earth entry vehicle provides about 50 cu. ft. per man and is housed within the mission module both for easy access and to provide a "cosmic radiation storm celler" because of its massive heat shield.

The excursion vehicles would provide some 250 cu. ft. of free space per man.

For both the Mars excursion and Earth entry vehicles, an entry corridor depth of at least 10 miles is required. About half of this is needed to accommodate mid-course guidance errors and half to handle variations and uncertainties in the atmospheres.

The range of Earth entry speeds for Mars missions is 48,000 to 70,000 fps. Corridors equal to or greater than 10 miles are provided by L/D = ½ (lift-to-drag) vehicles to 65,000 fps and L/D = 1 vehicles up to 70,000 fps. Mars entry speeds are about half of those for Earth entry, but there remain considerable uncertainties about the Martian atmosphere.

(Continued on p. 18)

● **Earth entry configurations**—Study of Earth-entry vehicle shapes was reduced to two configurations—the blunt *Apollo*-type and the M-1 half-cone shape—both of which are known to provide a lift-to-drag ratio of one-half. The vehicles were assumed to have volumes of 1,400 cu. ft. and weigh 8,500 lbs., exclusive of heat shield.

While heat shield weight increases with entry speed, the half-cone shapes reportedly showed a more gradual increase, and the reduction in shield weight for the slender configuration, as opposed to the blunt body, was said to be clearly evident at the higher entry speeds. It was also noted that weights can be further reduced by decreasing nose radii.

The study showed that at 36,000 fps entry speeds, the shield weight for a three-man vehicle is about 15% of the total entry weight, while at 70,000 fps it is about 50%. These percentages also reportedly hold true for other crew sizes. Entry weights for the 10-man crew size range from 10,000 lbs. at 36,000 fps to about 17,000 lbs. at 72,000 fps.

Three-man vehicles are about half these weights, according to the study.

● **Mars lander**—For the Mars excursion vehicle, only the blunt *Apollo*-type capsules were considered. The vehicle enters the atmosphere at about 12,000 fps, using a lightweight radiation-cooled heat shield.

A single-engine system is used for retro-thrusting during landing and for Mars launch. The propulsion system is assumed to be a hydrogen/fluorine system with a 450-second specific impulse.

Total Δ v requirements for the excursion vehicle were estimated to be about 17,000 fps. Module weight for a three-man crew and a seven-day stay-time is nominally 40,000 lbs. and increases about 5,000 lbs./man. Only a small weight increase is associated with longer stay times.

Using MOR and atmospheric braking, the effect of increasing stay time from seven to 87 days leads to about a 27% increase in overall minimum mission weight.

● **Sustaining the astronauts**—Within the mission module, major weight demands are made by the radiation shielding and the life-support system, with choice of the type of support system directly tied to the problem.

Two systems were considered, one an open-cycle system in which liquids, solids and gases are not reclaimed, and the other a partially closed system in which oxygen is recovered from carbon dioxide and water from liquid waste.

While the open system does not look attractive at first comparison, the additional mass required for radiation shielding with the partially closed system greatly reduces the differences. As a result, scientists believe the relatively simple and weight-competitive open system may be a better bet for early missions, but point out that the other system should also be developed for trips of longer duration. ■

Aerojet delivers first . . .

NAA Gets Production-Type Apollo Engine

FIRST production-type *Apollo* Service Propulsion System Engine has been delivered by Aerojet-General to North American Aviation, Inc., prime *Apollo* contractor, for ground-testing near White Sands Missile Range, N.M.

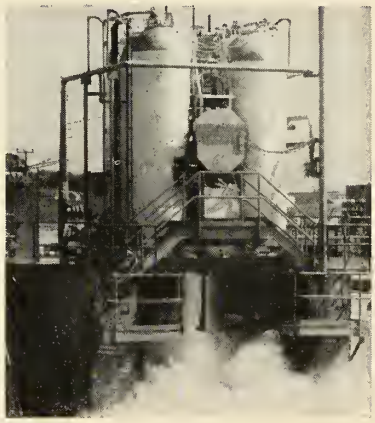
The 22,000-lb.-thrust multiple restart engine will provide the main source of power for the *Apollo* Service Module. It will maintain the spacecraft on its course to the Moon, insert it into lunar orbit, keep it there while two astronauts descend to the Moon in the LEM vehicle, aid in rendezvous of LEM and its mother craft, take *Apollo* out of lunar orbit, keep it on course during return to Earth, and insert it into reentry.

Employing *Titan II* Earth-storable and self-igniting propellants and redundant controls, the engine is designed to be capable of more than 50 restarts with long continuous operation.

Developmental engines are being static-tested with boilerplate *Apollo* tankage at Aerojet's Sacramento plant and at the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.

● **And a first J-2**—Meanwhile, the first J-2 engine of the type to be used in the *Saturn V* booster for *Apollo* was handed over to NASA by Rocketdyne Div. of North American Aviation.

The hydrogen-fueled engine, under development for three and a half years, develops 200,000 lbs. of thrust at altitude and is the most powerful rocket engine presently scheduled for use in upper stages of U.S. space vehicles.



EARLIER static firing of Apollo Service Propulsion engine at Aerojet-General. Engine itself is not visible in photo.

In the *Saturn V*, the J-2 will be used both in the S-II second stage—in a cluster of five engines developing a million lbs. of thrust—and in the single-engine S-IVB third stage. In the S-IVB it will be shut down during Earth orbit, then re-ignited to launch *Apollo* on its way to the Moon.

In the *Saturn IB*, J-2 will be used as a single engine in the S-IVB upper stage, launching astronauts in *Apollo* spacecraft into Earth-orbit training missions.

The engine was delivered to NAA after a series of demonstration test firings at Rocketdyne's Santa Susana Field Laboratory. It is being shipped to Douglas Aircraft Company for installation and test-firing in a ground-test version of the S-IVB at Douglas' Sacramento Missile Field Station.

Fifty-five engines and their supporting equipment are scheduled for production at Rocketdyne under a contract from NASA's Marshall Space Flight Center. A number of non-fireable J-2's have already been delivered to the space agency for use as simulators in early stage checkout. ■

Technical Countdown

PROPULSION

Bell Steps Up High-Energy Rocket Work

Bell Aerosystems Div. is checking out the water and construction capabilities at a site in New Mexico about 25 miles north of El Paso, Tex., for erection of a major high-energy propulsion facility. The Textron, Inc., subsidiary contracted with the Ralph Parsons organization for the initial work. The site was chosen after considering 131 locations in 18 states. The facility will be designed to develop and test high-energy upper stage propulsion systems covering all types of exotic fuels and oxidizers, including fluorine. The move by Bell is a direct response to NASA's interest in the development of second-generation, high-energy upper stages.

MATERIALS

Floating Bearing Supports 5 Million Lbs.

The massive hydrostatic bearing that will ultimately "float" NASA's new 210-ft. deep space tracking antenna, now under construction at Goldstone, Calif., will be built by the Rucker Co., Oakland, Calif., under a $750,000 contract. The Rucker bearing will permit the movable portion of the antenna—weighing approximately 5 million lbs.—to float on a frictionless surface of pressurized oil only 2½ times the thickness of a human hair. The entire facility, which will substantially increase the efficiency of the NASA/JPL Deep Space Net, is scheduled for completion in mid-1966.

Corning Supplies Solar Simulator Optics

More than 500 precisely manufactured segments of fused silica are being fabricated by Corning Glass Works for the NASA Goddard Space Flight Center six-story space environmental test chamber. The glass segments will be used in the 127 optical modules in the chamber dome to focus and collimate the light from high-energy mercury/xenon lamps. The lenses and reflectors align the light in parallel rays to closely approximate solar radiation. Each module contains four fused silica refractive elements and three metal reflectors. The light in each module is reflected into a three-lens condenser unit which focuses onto a 4.4-in.-dia. field lens. This transmits the energy to a Cassegrainian collimating system suspended inside the chamber.

Memory Arrays Molded by IBM

An experimental molding process is being used to fabricate memory arrays called Flute at IBM's Thomas J. Watson Research Center, Yorktown Heights, N.Y. Each storage cell in the Flute array can store or release information in 100 billionths of a second and a density of 2,000 cells/sq. in. has been achieved. A magnetic ferrite material is molded in the form of tiny tubes over a mesh of fine wires in a single step. The finished array consists of a set of parallel ferrite tubes held together by a set of wires, called bit lines, intersecting the tubes at right angles. Each tube contains a word line running along its axis. A grid of word and bit lines is sandwiched between halves of a matching grooved mold, pre-filled with ferrite and a thermosetting binder. After cure the array is sintered, driving off the organic binder.

ELECTRONICS

Computer-Based Calibration System at Douglas

An automated calibration control system programmed into an IBM 7090 computer is keeping a daily inventory on 30,000 pieces of precision instrumentation at Douglas Aircraft Co., Santa Monica, Calif. The computer keeps records immediately available on the measurement capabilities of the primary standards lab in Santa Monica and the secondary standards labs established at Douglas installations across the country. It provides two weeks advance notice of regularly required calibration and certification checks on individual equipment. The system makes it possible to step up servicing in certain cases while slacking off in others to maintain the required overall reliability.

PB440 Digital Computer Shipped

The initial model of the Packard Bell PB440 digital computer has been delivered and installed at the IIT Research Institute in Chicago where it will form the central element of a simulation system. Use of the PB440 will be initially for investigation of digital simulation techniques with the ultimate objective of simulating a manned orbital laboratory. IITRI will deliver the complete simulation system in May to the Aerospace Medical Div.'s human factors laboratory at Wright-Patterson AFB, Ohio.

High-Speed Switching System Developed

A switching system, containing 40,000 separate switching circuits and developed by Stellarmetrics, Inc., Santa Barbara, Calif., has been shipped to Jet Propulsion Laboratory, where it will be used to distribute incoming and outgoing teletype signals containing information from the world-wide satellite tracking network. The data can be switched to areas within the facility or to tracking stations anywhere in the world, providing engineers and scientists with instant information on the status of a spacecraft.

SPACE MEDICINE

CO_2 Tolerance Level Raised

Tests at the School of Aerospace Medicine indicate that astronauts may be able to withstand the higher concentrations of carbon dioxide that would occur if their CO_2 removal system should fail. Eight subjects showed no deterioration of performance when exposed to a 3% concentration of CO_2 in otherwise pure oxygen.

Exercise Meter To Be Tested

General Dynamics Life Sciences Laboratory has developed a unit that will be used in its manned rotating space station simulator to study the effect of exercise on astronauts. The transistorized, six-channel pulse-frequency electromyography and integrator and digital readout unit can be attached to six muscles. It weighs 10 lbs.

Three Companies in Competition For New AFMTC Missile Tracker

Optical, microwave, gamma-ray approaches under study; major launch-phase tracking improvement foreseen

by Michael Getler

ROME, N.Y.—Air Force scientists at the Rome Air Development Center (RADC) here are evaluating three industry proposals for a new launch-phase missile tracking system for the Air Force Missile Test Center at Cape Kennedy.

The technical proposals span the microwave, optical, and gamma ray portions of the spectrum.

RADC scientists are expected to complete their evaluation this month, recommending a single or perhaps combined system approach to the Electronic Systems Command by June 1. Responsibility for final approval of requested R&D funds will rest with Air Force Systems Command. ESD and AFMTC scientists are also taking part in the evaluations here, which began about two months ago.

If the development is approved and FY'65 funds are made available, RADC estimates it would have one prototype built, taking 12-18 months, followed by a 6 to 12-month evaluation period. Scientists estimate an operational system could be in service in about 2½ years.

The tracking system is designed to provide highly accurate position, velocity, and acceleration data on missiles and launch vehicles from the launching pad to 60,000 ft. If approved and developed, scientists here say the new system will yield at least an order of magnitude improvement in launch-phase data over what is now accumulated via CZR cameras and cinetheodolites during the early flight phase.

The accuracy specs that systems must meet are shown in the accompanying chart. The figures do not represent real-time accuracies, but those achieved after data reduction.

ALTITUDE REGION (ft.)	ACCURACY		
	Position (ft.)	Velocity (ft./sec.)	Acceleration (ft./sec.)
0- 500	0.05	0.02	0.01
500- 5,000	0.2	0.2	0.1
5,000-60,000	2.0	0.5	0.1

● **Welcome system**—Project engineers, optimistic about eventual development, say the boost-phase launch system will fill a vital gap left by other high-performance range instrumentation systems, such as Mistram, currently in final development. Complementing systems such as Mistram with the early-launch capability will allow detailed evaluation of existing and future AF launch vehicles, in particular the assessment of improved control, guidance, and propulsion systems.

Such a capability, scientists here stress, although ultimately required for new missile development, is needed to evaluate existing missile systems where proper evaluation has been lacking because of current limitations in tracking accuracies.

The AF, in November, 1962, requested studies of this problem from a number of firms and eventually settled on General Dynamics/Astronautics, San Diego, Calif., to pursue the microwave approach; the Perkin-Elmer Corp. Norwalk, Conn., for the optical laser technique, and Industrial Nucleonics Corp., Columbus, Ohio, for the gamma ray tracking scheme.

At the same time, the AF also funded Martin Marietta Corp.'s Electronic Systems and Products Div., to study a gamma-ray tracking method that applied the Mössbauer effect to velocity sensing during launch phase. The Martin effort, while judged to be extremely interesting, is not an active candidate for the AFMTC role because of the limited range of such a device. The technique is being explored as an advanced technology project.

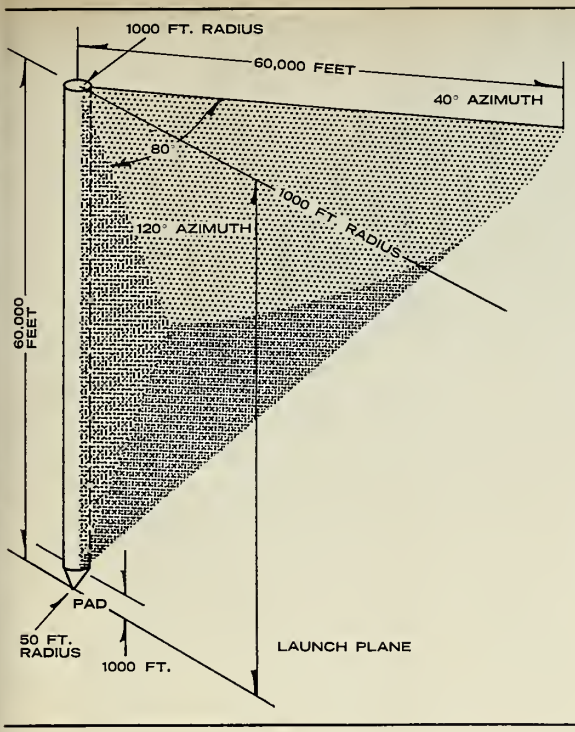
Contracts were completed and final reports turned in to RADC in mid-January.

● **Both systems are advances**—While the adoption of either system at the Cape would reportedly improve things, project engineers stress that both the optical and gamma-ray approaches also represent significant departures from standard techniques and are individually important advances.

Though the system is intended for operation from zero to 60,000 ft., each approach has some problems somewhere along the route (particularly at low altitudes for both the microwave and optical systems) and for this reason a combined system may get the nod.

Any combined system chosen is likely to include the gamma-ray technique, which is considered to have major advantages for all-weather operation and missile plume penetration, though presently limited in range.

Before the RADC investigation, engineers report that gamma-ray tracking had only been considered for space-borne application. Its use in a ground-



LAUNCH PHASE tracking geometry is shown in this diagram.

based tracking application is viewed with considerable interest.

● **Industrial Nucleonics approach**—the Industrial Nucleonics approach, a high-energy gamma source (Cobalt 60) is mounted on the aft end of the missile. The Cobalt 60 is described as a two-line source (1.17 Mev and 1.33 Mev) with a strength of 25 curies, emitted Earthward with shielding preventing emission back into the missile structure. Scientists here say the source would weigh about 10 lbs. The gamma source emits by disintegration, with the energy emitted at specific energy levels that can be related to frequency by Plank's constant.

The ground-based portion is made up of three azimuth and elevation angle measurement stations set 120° apart, each 700 ft. from the launch pad. Use of three stations to ring the launch pad also provides redundancy.

The angle-sensing tackers at the stations, according to RADC, are nuclear adaptations of RF amplitude-amplitude monopulse systems and are probably the first of their kind to be designed. The gamma detector is sodium iodide, doped with thallium to increase efficiency. Gamma photons hitting the detector crystal produce light flashes that are sensed by a photomultiplier tube, which in turn provides voltage pulses for counting.

The gamma-ray tracker is expected to yield high accuracies to altitudes of about 500 ft. but have a maximum range approaching 1,200 ft. at somewhat reduced accuracies. Despite its long-range limitations, it is the capability at short range that is interesting to engineers here, primarily because the technique experiences little or no propogation problems in comparison to the other approaches.

The technique has a very high penetrability factor that provides the sought-after all-weather capability. While the missile plume presents a high attenuation, "shimmer," and signal/noise ratio reductions with optical systems, the hotter, less-dense medium in the plume actually allows the gamma photons to propagate better.

Also, engineers cite advantages because of the straight-line propagation with gamma rays, avoiding refraction problems and providing a measured angle that is the same as the look angle. The technique also allows frequency discrimination against multipath photons entering the tracker.

In the tracker design, the collimator, or beam-forming device, is formed by shielding so that photons arriving via other angles have to penetrate the shielding and are thus attenuated.

Engineers here told MISSILES AND ROCKETS that "the only remaining problem with the gamma-ray approach is engineering, although there are certain disadvantages in terms of missile shielding weight and possible acoustic and seismic shock at the relatively close-in ground stations."

Experiments have already been held at Industrial Nucleonics' Columbus test range in which AF engineers say experiments verified theoretical work and detector configuration. The tests completed in November included checks on directivity and scattering of gammas.

● **Martin method**—The Martin approach using the Mössbauer nuclear resonance effect provides an extremely sensitive direct-velocity measurement device from which angular data can also be gathered. However, the current state of the art in this area would yield a very range-limited device for a launch tracking role, probably on the order of 100 ft. of altitude. But because of its extreme sensitivity, engineers see possible use for the system in space rendezvous applications, in which the system could propagate easily.

The problem, according to scientists here, is that the Mössbauer effect will not appear at energy levels above 136 Kev. If this effect could be made to occur at higher energy levels, the range could be increased. General Electric Co., Schenectady, N.Y., and the University of Washington, Seattle, are reportedly working toward this goal.

The system requires materials of the same atomic number at both the onboard emitter and the ground receiver. Cobalt 57 has been studied as the active element and iron 57 as the passive. Scientists here, however, say that there are other materials and that the most efficient found to date are samarium 151 and Europium 151.

● **Perkin-Elmer's OPDAR**—The Optical Direction and Ranging (OPDAR) system being developed by Perkin-Elmer Corp. also has several factors working in its favor, though engineers here admit that "the effect of weather at any altitude and atmospheric 'shimmer' at low altitude (in the first 500 ft.) still is largely an unknown. It is also still difficult to relate experimental tests performed at other locations to the Patrick AFB environment," they add.

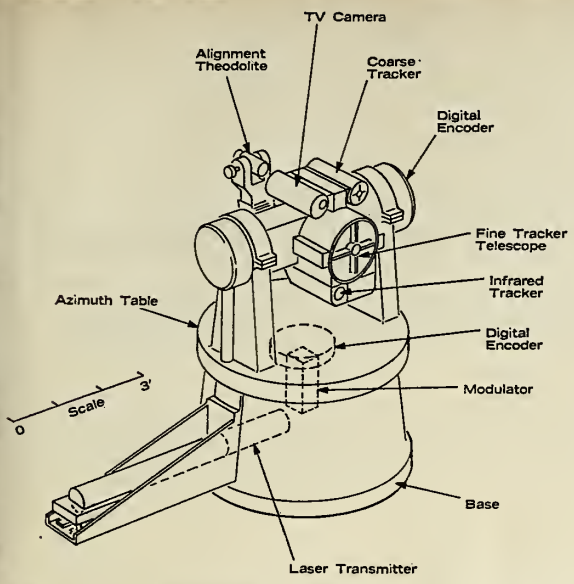
The advantages of the P-E approach, engineers say, is that it provides a relatively simple, mobile, single-instrument system at low cost and with very high angular tracking accuracies under good conditions. The extremely narrow laser beam will also cut down on signal multipath errors.

The system ground station can be located 3,500 ft. away (displaced about 45 degrees from the trajectory plane) from the launch pad and requires only a light-weight retro-reflector (a cluster of five high-index corner cubes) on the launch vehicle, with no on-board power.

The instrument measures elevation and azimuth angle and slant range to the single point on the vehicle where the retro-reflector is located. The preci-

You can't see the sun from the dark side of the Earth. Neither can a satellite. Republic's AOSO (Advanced Orbiting Solar Observatory) will precisely study the sun from a polar orbit in 24-hour-a-day sunlight for over six months straight.

AOSO is being built for NASA/Goddard by:
REPUBLIC AVIATION CORPORATION
Farmingdale, New York



PERKIN-ELMER'S OPDAR mount, one of three approaches being considered.

sion required in pointing the tracking mount, according to P-E, is an order of magnitude less than the measurement precision of the system.

The OPDAR system is described as an optical analog of a CW radar using the 6328 Angstrom output of a helium-neon gas laser as the carrier. The carrier is amplitude modulated at 100 mc/sec., with the phase of the modulated signal supplying the range data. The signal is also modulated on sidebands at 99 and 101 mc, with two of the three frequencies providing the unambigous range measurement. The laser source is capable of 100 mw output and the modulator is a multi-pass Pockels-effect device.

The tracker receiver includes a fine sensor with a 12-in. aperture, an 80 arc-sec. field-of-view, and a coarse sensor with a 6-in. aperture and a 200 arc-sec. field of view. The ranging receiver shares the fine sensor characteristics. Also included is an IR plume tracker with a four-degree field-of-view.

Perkin-Elmer has also run experiments over a one-mile path to verify initial development efforts.

In the microwave area, RADC did not specify the approach as it did in the others. The feeling was that there was microwave equipment already available for new application in this field, and that the full potential of microwaves had not been exploited.

● **General Dynamics method**—The approach GD/A came up with is basically a CW range range-sum system in a multilateration ground station setup that uses eight lightweight and transportable stations, and a two-channel transponder aboard the vehicle. The on-board transponder is the same as that used in the Glotrac system, transmitting 150 and 300 milliwatts.

Two of the ground stations are transmitter/receiver sites that measure range while the other receiver sites take range-sum measurements. Velocity and acceleration data can be differentiated from the range range-sum data. Of the two transmitter sites, the one closest to the launch pad puts out two watts and the one farthest away puts out 50 watts.

The eight stations are set up in a 60-degree spread, with the optimum missile trajectory down the centerline of the station layout. One receiver station is only 100 ft. from the pad; another is at 400 ft. Two more, one of which is a T/R, are at 1,000 ft. The next two, including the other T/R, are at 18,500 ft. One receiver is at 25,000 ft. on the centerline and the last is at 30,000 ft.

Use of eight stations provides redundancy and insures avoidance of the missile plume, which at the 5,000-mc band at which the system operates "can cause a 180-degree phase error." The two ground-based transmitters operate at adjacent frequencies to ease passing of transmitting function as the missile moves along its trajectory.

The receivers in-close use small fixed-position horn antennas and preamplifiers. The antennas at 1,000 ft. use 3-ft. dishes with conical scan trackers moving in azimuth and elevation. The remaining antennas are 5-ft. dishes with conical scan.

The disadvantages associated with this approach, according to engineers here, involve possible multipath propagation problems resulting from the relatively wide-beam antenna pattern, expense, and vulnerability to atmospheric refraction problems, although this is not expected to be as severe as with the optical approach, since the system does not take direct angular readings. ■



Gemini/MOL Combination

AIR FORCE Manned Orbiting Laboratory (MOL) and a modified Gemini capsule are shown in artist's conception. Combination will be launched from Cape Kennedy into a near-Earth orbit by Titan III-C booster to assess value of man performing military missions in space.

Gaseous-Core Rocket Rapidly Gaining Support as Feasible Engine System

by William Beller

THE GASEOUS-CORE nuclear rocket, pushed in recent weeks both by the House Space Committee and the President's National Aeronautics and Space Council, is shedding the science-fiction stigma attached to it by many scientists.

Although the feasibility of heating a propellant by a fissioning gas has not been shown, methods have been suggested that could lead to fashioning a test engine before the 1970's.

The gaseous-core concept, if it ends up in practicable spacecraft, could conceivably deliver payloads to the Moon for less than $5 per pound. Beyond this, it could bring the entire solar system into easy reach of Earth.

Impressed by testimony regarding the gaseous-core nuclear rocket, the NASA Oversight subcommittee of the House Space Committee, during its latest hearings this spring, recommended that NASA double its efforts in this field. Although the amount of money involved is small, bringing the total up to $3 million if the recommendation is carried out, the Congressional action reflects some of the support this advanced concept is getting.

To the chagrin of the staff of the NASA-Atomic Energy Commission (AEC) joint nuclear propulsion office, the House subcommittee also recommended that the additional money for the gaseous-core concept be taken from *Rover,* the solid-core nuclear rocket program.

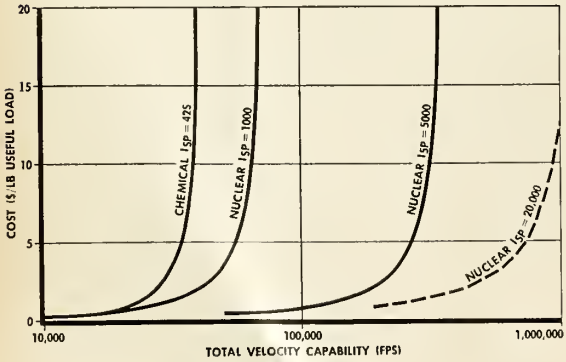
Another sign of the high official interest generated by the gaseous-core reactor is the recent statement by a prominent engineer who was then a professional staff member of the President's Space Council. "We are rapidly approaching (gaseous fission) engines," said Maxwell W. Hunter II. Now the technical director of Bellcomm, Inc., Hunter went on to say, "I think there is much more hope for such an engine than there was two years ago." He told MISSILES AND ROCKETS that scientists not acquainted with what has happened in gaseous-core technology during the past couple of years are "in for several surprises." He said that the advances made, some of them classified, could profoundly alter the views of the skeptics.

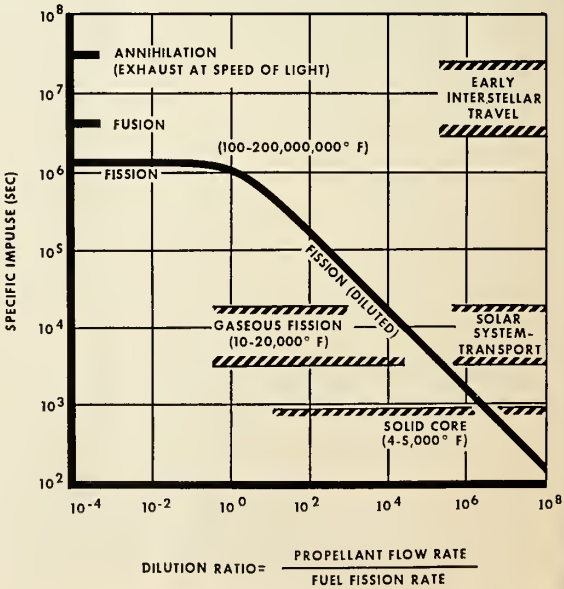
Hunter hastened to add that the gaseous-core rocket is not around the corner and advised against generating any excitement based on such an idea. Hunter, nevertheless, has just released to a limited number of key technical people a position paper, written while he was a member of the Space Council, showing the potential and status of the gaseous-core nuclear rocket.

This potential, in fact, is one of the main forces driving researchers into more work on gaseous-core reactors. A comparison is made with the *Saturn V.* For *Apollo,* the take-off weight of the rocket will be about 6 million lbs.; the return weight of the command capsule will be about 10,000 lb.

On the other hand, if a solid-core nuclear rocket were ready to be used

BELOW: Cargo transport costs for single-stage vehicles (Hunter). RIGHT: Specific impulse from nuclear reactions (Hunter).





in the upper stage, the return weight of the command module could be upped to about 25,000 lbs. for early engines and 70,000 lbs. for advanced ones.

A big jump occurs when the gaseous-core nuclear rocket is considered. Such a rocket is theoretically able to be built with a thrust-to-weight ratio of 20 and a specific impulse of 2,500 secs. On this basis, a capsule weighing almost 1 million lbs. could be brought back to Earth for "the same vehicle initial gross weight as the (*Apollo*) chemical system," George H. McLafferty, program manager for the gaseous-core nuclear rocket program at United Aircraft Corp.'s Research Laboratories, told the Oversight Subcommittee.

He assumed in his calculations that chemical rockets would be used to boost the nuclear stage outside the Earth's atmosphere in order to get rid of the radiation hazard. This complication reduces the payload, but only to a "relatively slight" extent.

● **Bounding the fuel**—The trick in a gaseous-core nuclear rocket is to contain the high temperature of the fissioning fuel and, at the same time, keep the fuel from flowing out the rocket nozzle with the propellant.

About a dozen ways for doing this are being studied by NASA, the AEC and industry companies, the latter including General Electric and Douglas Aircraft. Three of the concepts apparently have so much promise that they were classified—first by the Air Force several years ago, and currently by the AEC, which has taken over the work.

Less optimistic workers in the gaseous-core nuclear field say, however, that the classifications attached to their work are merely imprints of AEC interest; a government spokesman declares they have little relationship to "the feasibility of the idea or security of the nation." The Air Force, while enthralled by the possibilities of gaseous-core nuclear rockets, is said to have classified the work more out of hope than precept.

The value of a gaseous-core rocket lies in its potential to heat to a high temperature and eject vast amounts of a lightweight propellant such as hydrogen. High temperature is the key. Although it is possible to attain extremely high values of exhaust velocity by the electrostatic acceleration of charged particles, as in plasma and ion electric rockets, the resulting ratio of thrust to the sum of engine and power-supply weight is extremely low.

McLafferty maintains that "the only means for increasing specific impulse while still retaining high values of the ratio of thrust to weight is to increase the exhaust velocity by increasing the gas temperature. He points out that since the gas temperature in a solid-core nuclear rocket is necessarily limited by the structural characteristics of the fuel elements at elevated temperatures, "it is apparent that further increases in temperature will require the containment of nuclear fuel in gaseous form."

● **Nuclear light bulb**—For values of specific impulse between 1,500 and 3,000 secs., McLafferty estimates that the corresponding average temperatures immediately upstream of the nozzle throat would be between 10,000 and 30,000°F. Clearly, no unprotected material could exist in structural form at such temperatures. In view of this, United Aircraft Corp. Research Laboratories, E. Hartford, Conn., is looking into a concept called the "nuclear light bulb" with film cooling.

The idea is to retain gaseous fissionable fuel in a transparent container, permitting heat transfer entirely by radiation to the propellant flowing around the container. Possibly made of quartz or sapphire, the container would be cooled by a liquid circulating within its wall. Furthermore, the fissionable gas would be buffered by a thin film formed by bleeding part of the coolant through holes in the container's inner wall.

One of the big unknowns is the effect on the transparency of the walls created by such an accumulation of heat. United Aircraft has a small NASA contract to look into this problem. Researchers are running studies on transparent materials that have been colored by the radiations of a nuclear reactor. Such coloring reduces the transparency of the material, of course, and hence keeps radiant energy from efficiently passing through.

United Aircraft takes these materials, raises their temperature, and then watches the rate of annealing as a function of temperature. From this, the researchers can find out whether the rate of annealing is sufficient to overcome the rate of creation of the damage centers. Hence, they are learning whether they can get a material which will be transparent in the environment of the gaseous core of a nuclear rocket.

United Aircraft has already put about $800,000 of its own into gaseous-core work. In addition, it has spent about $1.15 million for the Air Force and $300,000 for NASA.

The nuclear light bulb idea was also conceived by Douglas Aircraft, where it is known as the "glow plug." So far, United Aircraft has spent about $80,000 on this concept, and $500,000 on a classified concept for gaseous-fuel containment.

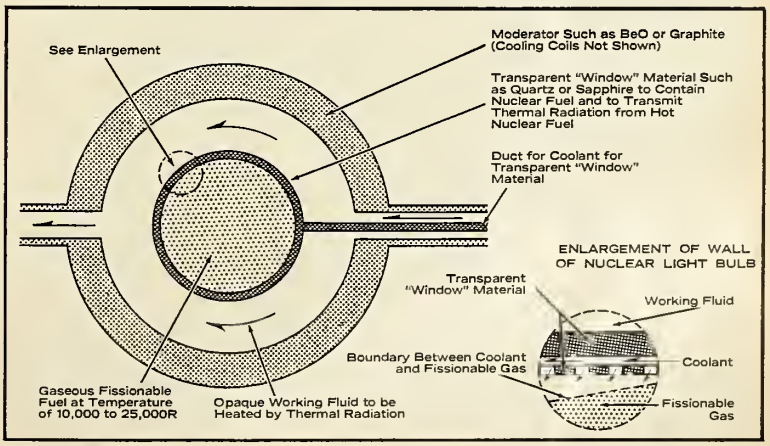
● **Hold back the mix**—Of all the serious study projects on gaseous-core nuclear rockets, the nuclear light bulb is the only one that sets up a physical boundary around the gaseous core. All the other concepts expect to realize some sort of mixing of the propellant and fissioning fuel.

For rocket engines with diameters ranging from 8 to 25 ft., United Aircraft reports that between 11 and 44 lbs. of fuel must be stored in the cavity reserved for the gaseous fuel. If this gaseous fuel is permitted to mix with the propellant, fuel loss rates approximately equal to propellant flow rates would result. This is intolerable, from the viewpoint of both engine performance and economics.

Among the suggested ways to limit the problem are magnetic containment of the fuel, mechanical containment by setting up appropriate flow patterns in the fuel, and classified methods which are said to involve systems of fluid-flow control.

So far, no theoretical barriers to the gaseous-core nuclear rocket have been spotted. A large amount of exploratory research will be needed to make an engine practicable. For the present, the need is to follow all paths that may lead to possible methods of fuel and temperature containment. ■

SKETCH OF nuclear light bulb with film cooling (UAC Research Laboratories).



Europeans Shying at Possibility of U.S.-Dominated Comsat Cooperation

Argument continues over make-up of board of governors; Britain's $40-million offer hinges on conditions; no technical data exchange

by Frank G. McGuire

HANOVER, W. GERMANY—European space experts are taking issue with the rosy picture U.S. Administration officials have painted of the progress of talks on international cooperation in the use of communications satellites.

Basically, the Europeans say, they are afraid the projected organization will turn out to be another NATO—nominally international but in fact, according to their view, run mostly as the U.S. sees fit.

Observers interviewed by MISSILES AND ROCKETS report that some progress is being made in the negotiations, but new difficulties arise as the talks get nearer to concrete agreement. In general, the Europeans are unwilling to agree to anything until the approximate form of the final treaty is known; the U.S. position is that a somewhat informal organization should be operated for a time on a trial basis, so that there will be no major bugs in the final treaty.

A key issue is the composition of what, for lack of any official designation, is loosely referred to as the board of governors. The U.S. wants it firmly established that the seats on the board are strictly proportional to the shares held by each member country. The European preference is that no single nation, even if it owns up to 50% of the shares, should have more than three or four seats out of the more than a dozen anticipated.

Briefly stated, the European attitude is this: "All right, so the Americans paid for most of the hardware. But it takes two to make a telephone conversation. We are in no hurry to get this system going if we can wait two or three more years, put our own up and run it the way we want."

Both the U.S. and Europe, the latter especially, want provision for inclusion on the board of governors of small African nations. This might be handled by having these nations, which could not afford as many shares as the larger countries, rotate a representative (or mutually agree to a permanent representative) on the board. This type of arrangement is already working successfully with Air Afrique, an airline serving and managed by 11 African states.

● **British "full part"**—Britain has gone on record as being willing to put up as much as $40 million toward the cost of a global system—if it secures acceptance of its conditions. These include a positive part for the United Kingdom in the design of the system, a share in both ownership and management, and a guarantee that Britain will provide some of the hardware.

British insistence that the U.K. "play a full part in the management of the system" is the key point at issue. What constitutes a "full part?" The recent London meeting of European countries interested in the satellite project debated the subject heatedly for several days.

To put the British offer of $40 million into perspective with the total costs involved, it should be noted that at the London meeting representatives of the U.S. Communications Satellite Corp. gave the following estimates for the system, to be spent over the next five years: satellites, $75 million; boosters, about $100 million; tracking, control and other ground facilities, $20 million. The total expected is thus about $200 million, but it is understood that the ground facilities mentioned here include only the U.S. portion. M/R sources say each other nation or group of nations would be expected to fund, emplace and operate its own receiving/transmitting station, with coordination of receiving/transmitting and overall utilization carried out by international procedures to be established.

At the London meeting, Britain proposed an apportionment system for the board of governors based on the amount of traffic generated by each country. It is not expected that this idea will be pressed, since traffic for almost all other countries is expected to increase at a far greater rate than that of the U.K., even though the proposal reportedly included all Commonwealth countries. If this proposal were to go through, the time might come when Britain would have less and less traffic on which to base a claim for a "full share in the management," unless the apportionment of seats were to be frozen at the time of treaty signing, in which case the U.K. would come out ahead of the game.

● **No official exchange**—The United States flatly refused any official exchange with European countries of technical information regarding communication satellites. This could make compatibility of the European Launcher Development Organization (ELDO) and Communications Satellite Corp. systems difficult. Industry cooperation is not barred, but exactly what form such cooperation might take is not known.

If there is little cooperation, and the U.S. system is adopted, it will unquestionably confirm fears held by many European space-oriented companies that they will be frozen out of the market.

Apparently having in mind this sore point of who is to provide hardware, the British Postmaster-General said one of the conditions which he is pressing is that ". . . if the system is extended, we want to provide satelittes, launchers and any other equipment that may be necessary."

Earlier this month, M. N. Golovine, vice-president of Eurospace, told a British audience that the ELDO plan for a communications network might suffer a "severe setback" if Western Europe enters into a "subservient" agreement with the U.S. Communications Satellite Corp. involving the virtually exclusive use of U.S. hardware for years to come.

Golovine said it is conceivable, although not inevitable, that Europe could decay into a technologically underdeveloped area if its space industry capabilities were allowed to wither due to lack of projects. He viewed the technological advances of Russia and the U.S. as a threat to the future potential of Europe as a source of technological leadership.

● **And now Russia**—A possibly complicating factor overshadowing the entire scene is Soviet planning in the field of communications satellites. Although it is not likely that much overseas traffic will develop between Russia and the West in the very near future, it is unquestionable that Russia has a considerable need for the same type of communications flow between her eastern and western extremities.

The USSR is now slated to begin talks with the State Department around June 15, talks which the Soviets reportedly have not been anxious to get under way because of a home-grown satellite communications system they have planned. According to a U.S. source here, "the Russian booster capability makes it possible for them to put a whole damn radio station into orbit."

During the London meeting, a European government delegate is reported to have commented to a U.S. delegate: "You think the Europeans are being difficult about this business, but what are you going to do when you start dealing with the Russians and tell them that the Pentagon will share the system?"

If the Soviets do agree to join in the proposed system involving the U.S., Europe, Japan, Australia and other parts of the world, it is believed by informed sources here that prestige will be their major motivation, with the dividend of a low-cost method of demonstrating cooperative attitudes.

● **Technical problems**—Despite the apparent attitude on the part of European sources that the ELDO communication satellite problems are "relatively simple," U.S. sources cite specific unsolved problems still on the drawing boards. It also should be noted that the Europeans who regard the satellite's design as a fairly straightforward problem in relaying signals are not the Europeans charged with carrying out that design.

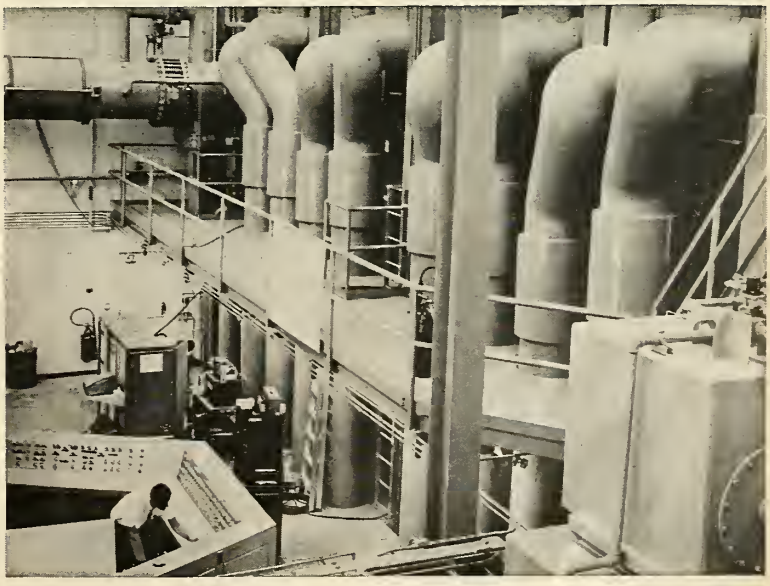
Major technical problems still faced by NASA designers, as spelled out for the House Military Operations Subcommittee, include: increased reliability of critical components, multiple access by ground stations to the satellite, attitude stabilization without on-board fuel consumption, and suppression of echoes caused by lengthy transmission times to and from a synchronous satellite.

Present launch date for the Early Bird series of initial communications satellites by Communications Satellite Corp., under a contract with Hughes Aircraft Corp., is now set at sometime next spring. CSC has not yet decided on a contractor for the two random-access medium-altitude comsat systems to be developed parallel to Early Bird. The medium-altitude system is expected to be in operation in 1966.

● **Next meeting**—The London meeting, which followed one in Rome, will itself be followed up by a session in Montreal this month. It will be both a technical and full-blown political meeting with the top delegates participating in an attempt to get the brass tacks polished. The U.S. delegation has consisted of: Abram Chayes, head of delegation and legal advisor to the State Dept.; R. Colino, Federal Communications Commission; Bernard Strassburg, chief of FCC's Common Carrier Bureau; Leo Welch, president of CSC; Dr. Joseph Charyk, CSC; and various specialists in many fields.

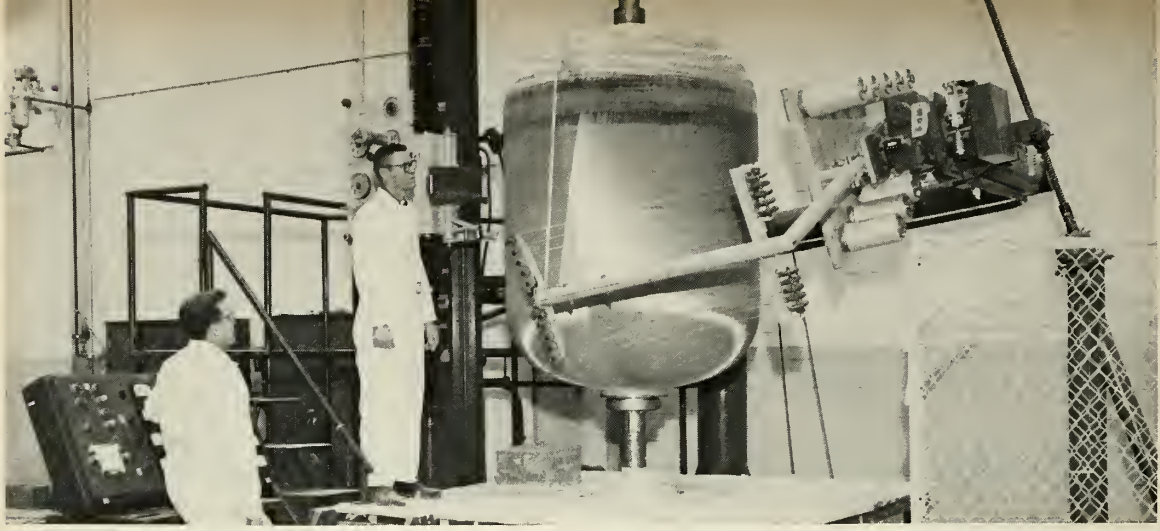
The British delegation is headed by Sir Charles Johnston, Foreign Office; Sir Robert Harvey, vice director general, General Post Office; J. O. Thompson, vice director, Bureau of External Telecommunications; and C. J. Stephens, Director for Space, Ministry of Aviation.

Canada's delegation consists of J. A. R. Baldwin, Vice Minister for Transport; M. F. G. Nixon, Director of Telecommunications and Electronic Affairs, Ministry of Transport: J. Jenkins, Canadian Overseas Telecommunications Corp.; and representatives of the Ministry of Economic Affairs. ■



Lockheed Space Chamber

BELIEVED TO BE largest in the nation is this 60-ft.-long, 25-ft.-wide, 21-ft.-tall high-altitude chamber being "lifted" to simulated 30-mi. altitude at Lockheed-California Co.'s Rye Canyon Research Center. Surrounded by pipes for cooling, chamber is now being used for tests on a space vehicle. Pumps remove air from chamber in less than six minutes.



Polaris A-3 second-stage motor case during filament winding at Brunswick Corp.'s Defense Products Div. The case is built on a sand mandrel perfected by the firm for the high-production rate Polaris program. The mandrel is washed out after fabrication.

advanced materials

Polaris Cases Wound in Nebraska

Brunswick's Lincoln facility uses sand mandrels, resin pressure impregnation to fabricate A-3 second stages

by John F. Judge

A MAJOR NEW filament winding production facility built by the Brunswick Corp. in Lincoln, Neb., is well into the *Polaris A-3* second-stage motor case program.

Brunswick was selected by Hercules Powder Co. as a production source for the *A-3* stage glass chamber. Cases are being produced under contract to the Hercules Bacchus, Utah, facility.

The new plant is designed for current weapon systems motor cases and a host of smaller pressure-vessel configurations. Additional modifications to existing winding equipment and possibly some new machines might be necessary before Brunswick could move into the 120-in. and larger case market.

Two major production innovations at the Lincoln plant are the mandrel materials and an in-house resin-impregnation process that extends Brunswick's control over the composite components in the end product.

● **Polyvinylized sand**—The *Polaris A-3* second-stage case is being production-fabricated on sand mandrels. The Brunswick-developed sand mandrel concept has been so successful meeting the tight tolerances of case winding that Hercules has directed all fabricators of second-stage cases to adopt the method.

Brunswick starts with highly consistent foundry sand and mixes batches with polyvinyl alcohols as the binder. Mixing is similar to concrete preparation. The batch is then packed into a mandrel mold.

The inside surface of the mold is covered with the *Polaris* case liner so that the final sand mandrel is immediately ready for winding.

The formed mandrels are oven-cured to drive off all volatiles. The major problem with the sand approach is determining the proper cure cycle. Brunswick engineers have related curing stages to moisture content, using the latter as the cure-state indicator. There has never been a mandrel failure in the program.

After the winding and glass-resin cure cycle is completed, the mandrel is washed out with water at ambient temperatures in an operation taking one to two man-hours. There are 4,400 lbs. of sand in each mandrel.

The sand mandrels have a rated compressive strength of 2,500 psi—capable of maintaining stability with the high comprehensive loads characteristic of filament winding.

Engineers at the Lincoln plant say the mandrel can be used for larger-diameter motor cases, but claim the approach is uneconomical for massive booster cases such as the 156- and 260-in. diameters.

● **Impregnation innovation**—In addition to the mandrel development, Brunswick has perfected a process for pressure impregnation of the glass roving with resin without "B" staging. The firm is also familiar with the standard handling of preimpregnated, "B"-staged roving.

Both approaches allow greater opportunities to apply quality control sampling techniques before winding the final shape. This assures the desired resin-to-glass content in the finished product.

Brunswick entered the filament winding fabricating field early in 1958. First product applications were nose radomes for the F-106 jet fighter.

Brunswick-fabricated radomes are now in use on the F-105, F-106, A-6A (Intruder), F-4B, F-4C, RF-4C and on Swedish and French jet aircraft. The *Bomarc B* nose cone was produced through this process.

There are two major plants in the Brunswick filament winding family—



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U.S. Navy Electronics Laboratory (NEL), San Diego
U.S. Naval Civil Engineering Laboratory (NCEL), Port Hueneme
U.S. Naval Ordnance Laboratory (NOLC), Corona
U.S. Naval Radiological Defense Laboratory (NRDL), San Francisco
U.S. Naval Personnel Research Activity (NPRA), San Diego
U.S. Naval Weapons Station, Quality Evaluation Laboratory (QEL), Concord
U.S. Naval Weapons Station, Quality Evaluation Laboratory (QEL), Seal Beach
U.S. Naval Ship Missile Systems Engineering Station (NSMSES), Port Hueneme

All qualified applicants will be considered for employment without regard to race, creed, color, sex, or national origin.

U.S. NAVAL LABORATORIES IN CALIFORNIA

the new Lincoln facility and a fabrication center at Marion, Va. All filament-wound radomes and electronic windows are at the Marion facility, while Lincoln handles motor cases, pressure vessels and other non-electronic application areas.

● **Lincoln line**—The building at the Nebraska site occupies a total area of 54,250 sq. ft. with about 11,000 of this reserved for filament winding operations. Temperature and humidity levels are precisely controlled in this area.

A hydrostatic test cell sized to accommodate motor cases up to eight feet in diameter and 20 ft. long nestles in one corner of the building, together with its adjoining control room.

The remainder of the factory holds curing ovens, raw material storage, receiving and shipping, inspection, quality control testing and plant maintenance.

The Lincoln plant can handle fabrication of motors from small experimental items to cases seven feet in diameter and 15 ft. long. Equipment for winding larger structures has been designed and will be installed in the 40-ft.-high manufacturing area as the need arises.

● **Winder details**—Brunswick's vertical universal winder wraps up to 16 strands simultaneously. The machine is designed for either biaxial or helical patterns on maximum-size chambers. The unit's indexing controls permit a ribbon width of up to 4.5 in. for longitudinal fibers. Magnetically controlled tensioning devices allow the use of single- or multiple-end roving.

The horizontal universal winder rotates the mandrel about any pre-selected axis while the roving is fed from a stationary creel. A transversing roving guide allows helical winding patterning. The machine will handle cases up to 6 ft. in diameter and 10 ft. long with a maximum chamber length for biaxial winding of 52 in.

Subscale chambers and small bottles are wound on a small vertical winder that lays down a single strand at a time in a biaxial pattern on mandrels up to 24 in. by 24 in. An indexing feature permits ribbon widths up to 2 in. in the longitudinal direction.

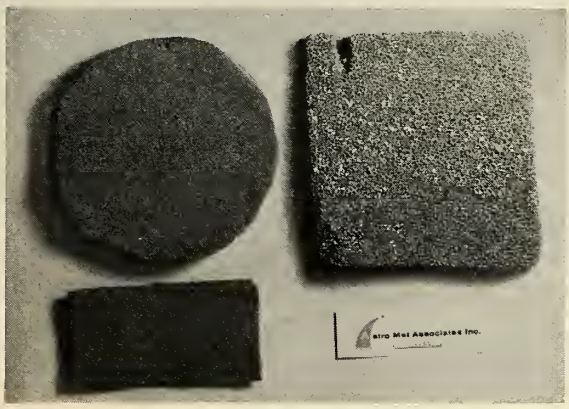
The Brunswick roving impregnator soaks a maximum of 25 lbs. of 12-end roving per hour to an exactly specified resin content—within ±2%. The roving is removed from the delivered package, impregnated and rewound on production spools with no twist and a minimum of pulley traversing.

In addition to the fired-gas curing ovens, the facility has a vertical boring mill with universal head and work size limits of 100 in. across and 100 in. long. The mill has been modified by adding a holding fixture that allows accurate indexing and boring of motor case nozzle and igniter ports. ■

Firm Exploring Uses For Foamed Tungsten

FOAMED TUNGSTEN with bulk densities as low as 0.475 grams/cc—about 2.5% theoretical density—is now a reality through a proprietary process developed by Astro Met Associates, Inc.

The porous refractory is being evaluated for transpiration-cooled rocket applications, lightweight high-temperature sandwich structures and thermionic emitters impregnated with low-work-function oxides. It costs $10-20/cu. in.



NEW LIGHTWEIGHT foamed tungsten appears at right, in comparison to some of Astro Met Associates' denser tungsten foam. Material has bulk densities as low as 0.475 grams/cc.

John W. Graham, president of Astro Met, says the development is the direct result of three distinct but slightly related breakthroughs in the firm's Cincinnati laboratory.

Astro Met is stingy with process details, describing it as a foaming and sintering method heretofore applicable only to other lower density metals and ceramics.

Designated AmPorTung-200 by its developers, the material has average pore diameters of about 1,500 microns. Astro Met produces smaller pore-diameter AmPorTung structures having bulk densities selectively controlled from as low as 5% to more than 30% theoretical density. Compressive strength is significantly better than that of the lower tungsten foams.

● **Purity stressed**—The low-density tungsten foam exhibits unusual purity in that spectrographic analysis indicates no detectable contamination by 43 of the most common metallic elements.

The purity is acheived by vaporizing initial contaminants through the porous structure during high-temperature vacuum sintering. As with all sintered structures, AmPorTung must be heated above its transition temperatures to overcome brittleness.

The foam has been found useful for high-temperature vacuum furnace setter plates and specimen holders because of its high purity, low thermal mass and low reactivity with most other refractories.

The high-pore continuity of the open-cell material results in high gas or liquid permeability—a necessity for elevated temperature gas filtering. This characteristic is desirable for resistance-heated vapor-depositing wicks for thin-film aluminizing.

● **Easily formed**—The firm has developed machining techniques for preparing unusual shapes. At the moment, AmPorTung-200 sizes can be made up to about 5-in. maximum dimension.

The material can be readily shaped at room temperature by fine-tooth saws, abrasive wheels and by careful picking.

The feather-light, water-floatable tungsten foam is the latest in a series of similar structures made from sintered ceramic and metal materials. Porosities range below one micron to 2,000 micron pore diameters.

In addition, the firm supplies high-density refractory ceramic, metal and intermetallic structures—including alumina, zirconia, magnesia, hafnia, thoria, nickel, molybdenum, tantalum, rhenium and tungsten. ■

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Mergers and Acquisitions

The Bendix Corp. has entered a contract to acquire the business and assets of Scott Testers, Inc., Providence, R.I., through an exchange of stock. Scott specializes in the field of physical-properties testing instruments and equipment for the rubber, plastics, wire, paper and textile industries. Scott will continue to operate in Providence under its present management as a wholly owned subsidiary of Bendix. . . . *The Washington Aluminum Co., Baltimore, Md., and Enterprise, Ala., has acquired from the I-T-E Circuit Breaker Co., Philadelphia, all patents, rights, drawings, tools, fixtures and test equipment formerly used by I-T-E in manufacturing waveguide and microwave components.* . . . HYSOL Corp., Olean, N.Y., has purchased the assets of the Power & Communications Div. of the Robertson Electric Co., Buffalo, N.Y. . . . *Magnion, Inc., Burlington, Mass., has acquired the physical assets of the Electromagnet Div. of the Harvey-Wells Corp. Both firms have been engaged in the design and manufacture of advanced electromagnet systems to assist scientists in conducting basic research studies.* . . . Fairchild Camera and Instrument Corp.'s Semiconductor Div. and Sperry Semiconductor have entered agreement under which Sperry is licensed to use the Fairchild Planar process in the fabrication of transistors and microcircuits. The agreement also provides that Fairchild may use certain Sperry patents through cross-licensing if desired. . . . *McDonnell Aircraft Corp. has agreed to buy 400,000 of newly split Hycon Manufacturing Co. stock, bringing its total holdings in the Monrovia, Calif., firm to 55.6%. Stockholders of Hycon have voted a one-for-five reverse split in common stock and also approved a change in the authorized common stock from 6.5 million shares of $.10 par value to 2 million shares of $.50 par value. Shares outstanding subsequent to the reverse split will total 1,249,530.*

New Activities

Air Reduction Sales Co., a division of Air Reduction Co., Inc., New York City, has established an Aerospace Systems Group in Jersey City, N.J., to handle government inquiries requiring development of engineering data and preparation of proposals for aerospace projects. The new group will function as part of the Cryogenics Engineering Department and will be closely associated with activities involving cryogenic systems for space simulators, cryopumping, and storage and transfer systems. . . . *Westinghouse Electric Corp.'s Scientific Equipment Dept. has formed a new group to design and manufacture vacuum systems and accessories, initially to operate in the company's molecular electronics plant at Newbury Park, Calif. The group will build standard and custom vacuum systems for applications in space simulation, vacuum deposition and environmental testing.* . . . General Dynamics Corp.'s Astronautics Div. has formed a new product organization devoted to manned space systems.

Industry Facilities

Hexcel Products, Inc., Berkeley, Calif., producer of structural honeycomb materials, is transferring its Texas manufacturing facility from Irving to Graham, Tex. Hexcel plans to have the new facility in operation by June. . . . *Elder Industries, Inc., South Gate, Calif., manufacturer of inert missile components, has begun construction of a new facility at North Beach in Newport Beach, Calif.* . . . Swedlow, Inc., aerospace plastics manufacturer, has opened the first unit of its new plant in Garden Grove, Calif. The 70,000-sq.-ft. plant will house aircraft transparencies and laboratory activities. Remainder of the company is still situated in central Los Angeles. . . . *Lavoie Laboratories, Inc., Morganville, N.J., has opened a new 6,400-sq.-ft. Research and Development Center in Hackensack, N.J. The new lab will conduct research in the areas of ferrite devices, microminiature devices and solid-state displays.* . . . International Business Machines Corp. has announced plans for a major facility at Huntsville, Ala., to enable IBM to handle new responsibilities on the *Saturn* vehicle program. IBM is a recent recipient of a NASA contract to provide assistance to Marshall Space-flight Center in the design, assembly, checkout and integration of instrument units for the advanced *Saturn*. . . . *Aerotest Laboratories, Inc., Bay Shore, N.Y., is moving to new facilities in Queens, N.Y., to accommodate expansion of its Northeastern Testing Laboratories. NET Laboratories will offer environmental testing for missile/space and aircraft components.* . . . Thiokol Chemical Corp. has begun construction of a new high-energy propellants plant in Brigham City, Utah.

Company Representatives

Fairchild Semiconductor, Mountain View, Calif., has appointed Powell Electronics, Inc., with offices in Philadelphia and Beltsville, Md., to distribute Fairchild's transistors, diodes and integrated circuits. . . . *Waveguide, Inc., Caldwell, N.J., has contracted with Sales Representatives to handle its standard waveguide test equipment and special waveguide plumbing assemblies in Florida, Georgia, Alabama, Mississippi, Tennessee, South Carolina, North Carolina and southern Virginia.* . . . North Atlantic Industries, Inc., Plainview, N.Y., developers and manufacturers of electronic test equipment and servo systems, has named Western Electro Dynamics Co., of Seattle as its exclusive sales representative in the Northwest. . . . *General Resistance, Inc., New York City, manufacturers of precision wire-wound resistors, resistor networks and instruments, has appointed the Ed Landa Co., Los Angeles as western states sales representative for Gen Res networks and components and Wieler & Co., Inc., Downey, Calif., as instrument sales representative.*

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contracts and procurements

AWARDS

AIR FORCE

$1,400,000—**Philco Corp.,** Blue Bell, Pa., for provision of technical communication facilities.

$202,829—**University of Rochester,** Rochester, N.Y., for theoretical research on optical and electronic properties of solids and investigation of the band structure of solids and electron-phonon interactions.

ARMY

$1,548,940—**S & S Contractors,** Lancaster, Calif., for construction of a toxic rocket research facility at Edwards AFB, Calif., to be comprised of two single-bay test stands, one two-way test stand, control building, high-pressure gaseous nitrogen distributing system and data acquisition system.

$1,360,330—**Hayes International Corp.,** Birmingham, Ala., for seven launchers for the *Sergeant* guided missile program.

$1,257,736—**Aerojet-General Corp.,** Sacramento, Calif., for *Hawk* rocket motors.

$1,200,000—**C. H. Leavell & Co.,** El Paso, Tex., and **Peter Kiewit Sons' Co.,** Louis, Miss., for construction of a *Saturn A1* test stand foundation at Mississippi Test Operations.

$1,146,216—**Fryd Construction Co.,** Miami Beach, Fla., for construction of three permanent *Hawk* antimissile missile facilities near Homestead AFB, Fla.

$700,000—**Northrop Corp.,** Ventura Div., Beverly Hills, Calif., for delivery of fifty RP-78 rocket-powered target missiles.

$351,020—**Chaney & James Construction Co., Inc.,** Richardson, Tex., for construction of mooring facilities at the cryogenic dock at NASA's Mississippi Test Operations.

$46,229—**General Electric Co.,** Defense Electronics Div., Syracuse, N.Y., for production of a HIPAR radar system for *Nike* missile application.

$32,850—**Martin-Marietta Corp.,** Orlando, Fla., for R&D on high sensitivity accelerometers.

$31,225—**ITT Gilfillan, Inc.,** Los Angeles, for cables for use in the *Corporal* missile system.

$29,398—**Belock Instrument Corp.,** College Point, N.Y., for spare parts related to the *Hawk* missile simulator station.

$26,325—**Vinson Manufacturing Co., Inc.,** Van Nuys, Calif., for repair parts applicable to the *Nike* missile system.

NAVY

$2,500,000—**Hercules Powder Co.,** Wilmington, Del., for R&D work on *Polaris* IRBM second-stage engines.

$1,200,000—**Sperry Rand Corp.,** Sperry Gyroscope Div., Great Neck, N.Y., for work on the *Talos* missile weapon system.

$900,000—**General Dynamics Corp.,** Pomona Div., Dangerfield, Tex., for evaluation and test of the *Talos* missile.

$385,185—**Vitro Corp. of America,** Vitro Laboratories Div., Silver Spring, Md., for continuation of research and development on guided missiles.

$149,996—**Raytheon Co.,** Bedford, Mass., for development of a fixed antenna radar for missile guidance.

$73,300—**The Carborundum Co.,** Niagara Falls, N.Y., for R&D of advanced ceramic systems for rocket nozzle applications.

Westinghouse Electric Corp., Defense & Space Center, Pittsburgh, Pa., for Underwater Launch Current and Energy Recorder (ULCER) equipment for the *Polaris* weapon system (amount undisclosed).

NASA

$7,700,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for assembly and launching of *Delta* space research vehicles.

$1,000,000—**Northrop Corp.,** Norair Div., Hawthorne, Calif., for two low-speed research gliders for use at Edwards AFB to study piloting of advanced spacecraft during landings.

$500,000—**Tate Engineering, Inc.,** Architectural Products Div., Baltimore, Md., for the manufacture and installation of 185,000 sq. ft. of flooring in NASA's Vertical Assembly Building, Cape Kennedy, Fla.

$121,032—**Astro Research Corp.,** Santa Barbara, Calif., for studies of rotating structures in space.

$92,200—**Operations Research, Inc.,** Silver Spring, Md., for an extensive reliability evaluation of the *Advanced Orbiting Solar Observatory* for Goddard Space Flight Center.

$67,758—**Allied Research Associates, Inc.,** Concord, Mass., for development and application of basic principles for materials and design synthesis to advanced concepts for space and launch vehicles.

$48,084—**Moore-Peterson Associates,** Santa Barbara, Calif., for a survey study of interface problems in microelectronics.

$36,680—**High Voltage Engineering Corp.,** Burlington, Mass., for an electron and proton accelerator.

$35,000—**Aerospace Controls,** Santa Monica, Calif., for a solar simulator system.

$30,103—**Jarrell-Ash Co.,** Waltham, Mass., for a spectrograph system.

MISCELLANEOUS

$787,000—**Martin Co.,** Baltimore, Md., from **The Boeing Co.,** Seattle, Wash., for 35 high pressure helium storage bottles for the *Saturn V* first stage.

$480,000—**United ElectroDynamics, Inc.,** Pasadena, Calif., from **The Boeing Co.,** Seattle, Wash., for airborne transmitters and equipment for telemetry systems and subsystems for *HIBEX* and *Minuteman* programs.

$225,700—**American Machine & Foundry Co.,** Atomics Div., Greenwich, Conn., from the **Japanese Atomic Fuels Corp.,** Tokai-Mura, Japan, for the "chop-and-leach" facility of a nuclear fuel reprocessing plant under construction in Japan.

$200,000—**Stewart-Warner Corp.,** South Wind Div., Indianapolis, Ind., from **The Boeing Co.,** Seattle, Wash., for electric-motor-driven air compressor assemblies for use with the shock isolation system of Minuteman underground launch control centers at Wings I through V.

$96,000—**Panhandle Aviation, Inc.,** Omaha, Neb., from **The Boeing Co.,** Seattle, for helicopter services during site activation of Air Force *Minuteman* Wing VI near Grand Forks, N.D.

Computer Controls Co., Inc., Framingham, Mass., from **Hughes Aircraft Co.,** Culver City, Calif., for an Alpha Scattering Experiment Data Translator (ASEDT).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics & Space Administration
Headquarters Contracts Division
Washington, D.C.

Study of scientific mission support study for the Apollo logistic support system. RFP 10-3140 to be issued in near future. Information may be obtained from Mr. Weirich, Area Code 202, WO 2-0283.

National Aeronautics & Space Administration
Manned Spacecraft Center
2101 Webster-Seabrook Road
Houston, Texas 77058

Study contract concerning pilotage (analytical evaluation of pilot capability to perform navigation with reference to lunar landmarks. RFP-MSC-64-12772P issued approximately 4/22/64. RFPS will be issued only until supply exhausted. Contact J. E. Jones, Jr., HU 3-2241.

Air Force Special Weapons Center
Procurement Directorate
Attention: SWMKB
Kirtland AFB, New Mexico 87117

Development support and production of a limited number of dummy warbeads for a guided missile. Proven capabilities of recent experience to fabricate, assemble and perform acceptance testing of same. Limited number of drawings available; first qualified, first served until depleted. RFP 640425 "Q" due 5/15/64. Request must be submitted in writing.

National Aeronautics & Space Admistration

Negotiating with National Research Corp., Cambridge, Mass., for study of the mechanism of atmospheric interaction with the fatigue of metals. Based on unsolicited proposal. For information only.

National Aeronautics & Space Administration

Negotiating with Astronautics Div., Ling-Temco-Vought, Inc., Dallas, Tex., for simulator evaluation of advanced integrated display and control systems. RFP not available. For information only.

National Aeronautics & Space Administration
Goddard Space Flight Center
Greenbelt, Maryland
Attention: Contracting Officer, Code 248

Time code system study to survey and analyze time codes used in tracking systems with attention to compatibility of time codes now in use. Recognized authorities on time codes are desired. RFP PCN 69938 due 5/18/64. Requests for RFP packages received after 5/1/64 will be honored for informational purposes only.

National Aeronautics & Space Administration
Goddard Space Flight Center
Greenbelt, Maryland
Attention: Contracting Officer, Code 248

Data compression and time resolution study for purpose of making more efficient utilization of satellite-to-ground station PCM telemetry links. RFP PCN 68326 due 5/15/64.

National Aeronautics & Space Administration
Flight Research Center
P.O. Box 273
Edwards AFB, California 93523

Services and material necessary to maintain, repair and test analog computer system. Must have direct experience, qualified employees available and not less than secret security clearance. RFP PR 1 available 4/27/64 and will be furnished to extent available. Oral briefing to be held 5/8/64. Advance notice of intention to attend shall be furnished.

Air Force Flight Test Center
Directorate of Procurement/FTMKL-2
Edwards Air Force Base, Calif. 93523

The Government is considering issuing an RFP/IFB for fabrication and installation of a prototype propellant test system at Rocket Propulsion Laboratory, Edwards AFB. Bidders must furnish evidence of experience. Information relative to experience must be submitted by 5/11/64 to the Buying Office.

National Aeronautics & Space Administration
Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Texas 77058

NASA is conducting negotiations with North American Aviation, Inc., Space & Information Systems Div., Downey, Calif., for a Pisgah Crater-radar return study. RFP not available; for information only.

Air Force Systems Command
Headquarters
Space Systems Division
Los Angeles, Calif.

Negotiations are being conducted with General Electric Co., Radio Guidance Operations, Syracuse, N.Y., for a contract to provide a reliability program in accordance with MIL-R-27542A. This is a follow-on to a previous effort. RFP not available; for information only.

National Aeronautics & Space Administration
Western Operations Office
Santa Monica, Calif.

Contractor is to operate a technical media reference and film distribution center and also to inventory, maintain and distribute educational publications. RFP 64-15 due 5/4/64.

National Aeronautics & Space Administration
Headquarters
Washington, D.C.

NASA is negotiating a contract with Bolt, Beranek and Newman, Cambridge, Mass., for continued studies of manual control systems. RFP not available. For information only.

Office of Naval Research
Washington 25, D.C.

Negotiations are being conducted with Lockheed California Co., Burbank, Calif., for research on flare-associated filament phenomena under Contract Nonr-4538(00). RFP not available; for information only.

National Aeronautics & Space Administration
Headquarters
Washington, D.C.

NASA is negotiating with Physics International Co., Berkeley, Calif., for development of a high-explosive, hyper-velocity particle acceleration gun. RFP not available; for information only.

book reviews

CODE NAMES DICTIONARY, Frederick G. Ruffner, Jr., and Robert C. Thomas, editors, published by Gale Research Co., Book Tower, Detroit, Mich., 555 pp., $15.00.

A tool for researchers, students, writers, historians, governmental agencies, defense contractors, scientists, the military and all who want or need identification of military and scientific terms of the present and recent past is found in the "Code Names Dictionary."

With the help of contributing editors from the Air Force, Army, NASA and the U.S. Weather Bureau, the editors have compiled a glossary of more than 8,500 code names, cover words and nicknames. The list includes terms applied both for purposes of security and easy identification. Entries, however, are not drawn from the many specialized fields that have developed their own vernacular. Terms must have achieved "some substantial degree of public recognition."

The dictionary covers terms and appelations applied to people, places, aircraft, hurricanes and projects in seven categories: World War II, the Korean hostilities and the peacetime activities of the Armed Forces since 1945; aviation and aircraft; military and scientific space activities; missile systems and equipment; weather phenomena; data processing; and atomic energy projects and tests.

The familiar terms are there—Tokyo Rose, Friendship 7 and Project Manhattan. Also listed are Pillowcase, Grapefruit, Rat Week and Illogical—applied to Hiroshima during World War II.

Although the title indicates this is a book of "names," acronyms that can be pronounced or which might be mistaken for a true code name or nickname are included. Examples are PLUTO and SNAP. With a few exceptions, alpha-numeric designations are omitted.

The book does not attempt to provide technical explanations, but rather identification for both layman and specialist in those areas of public affairs where "an understanding of specialized but esoteric and exotic terms is essential."

THE RISE AND FALL OF THE SPACE AGE, Edwin Diamond, Doubleday & Co., Inc., Garden City, N.Y., 158 pp., $3.95.

Mr. Diamond expects too much. He would have us divorce the promise of Space from the vulgar and ridiculous earth-bound aspects of the reality, the achievement of manned spaceflight from the circus which surrounds it, the pace of space activities from the artificial and wasteful pursuance of a space race.

Finally, he would have us examine the reality rather than the rhethoric of Air Force planners who becry a space "gap." He points out that twice in the past, "gaps" —the bomber and missile—have "proved to be creations in part of poor intelligence, of press agentry, of political campaign oratory, of the struggle for fatter appropriations and, only in part, of a genuine concern for national security."

The chapter, "The Show Business of Space", is a fascinating examination of the transformation of the original astronauts from seven men picked to do a job into seven celebrities whose commercial value, both to themselves and their exploiters, "encompasses all."

There are two faults with Mr. Diamond's book. First, it is too short. A critical examination of the space program is needed, but it cannot be done in 158 pages. The second failing is that, although the bookjacket blurb says that he "outlines a scientifically valid and economically feasible program," this reviewer could not find it—except by indirection. Mr. Diamond is a Senior Editor of Newsweek and, before that, the magazine's science editor. JLT

DSIF Tape Recorders Will Reduce Footage Needed for Future Missions

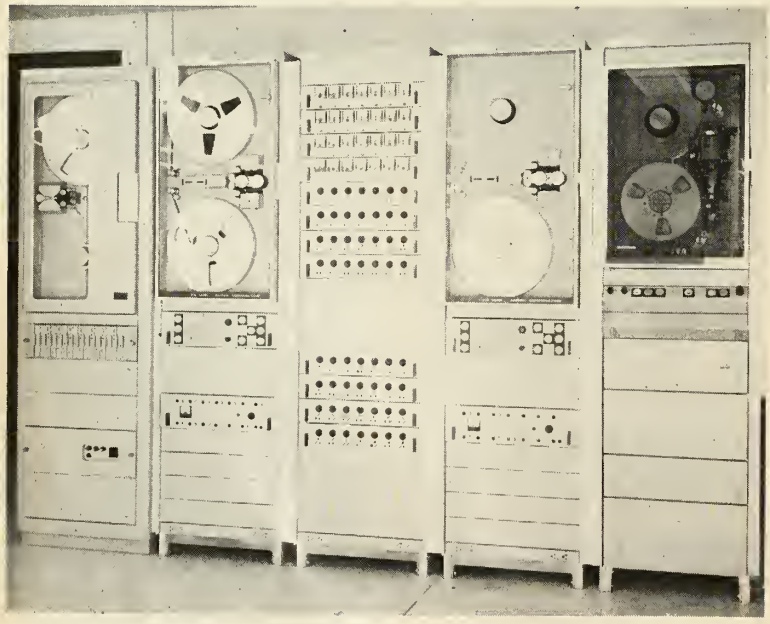
by Rex Pay

PASADENA, CALIF.—New tape recorders being installed at tracking stations of Jet Propulsion Laboratory's Deep Space Instrumentation Facility (DSIF) will cut the amount of tape needed to store data sent back by future spacecraft such as *Surveyor* and *Mariner B*, by eight times, compared with the amount used in the *Mariner II* Venus flyby.

Mariner II data tapes accumulated at the rate of 12 reels a day during the 129-day flight, with data coming in at the rate of 33 bits per sec. initially and at 8⅓ bits per sec. three days after launch. These information rates correspond to bandwidths of 1,200 cps and 300 cps.

Surveyor will provide signals with more than 100 times this bandwidth and *Mariner B* will provide over 10,000 bits per sec. early in its flight.

The new tape recorders being installed—Type 1400 machines produced by Ampex Corporation—will enable simultaneous recording of three types of signal from *Surveyor*—the detected video signal from the television channel, the raw telemetry data before detection, and the pulse code modulation telemetry, after detection.



TWO NEW Type 1400 recorders are housed in three center racks. Type 700 rotary head recorder (right) will be used for wideband pre-detection recording.

● **Updating**—The DSIF stations are also in the process of being equipped for use at S-Band instead of L-Band; this is a program separate from the updating of the recording capability and will take longer.

At DSIF stations, two recorders are run simultaneously, arranged so that one will continue recording while the reel is being changed on the other.

Two FR1400's have been installed at the two Goldstone, Calif., stations. Similar sets will be installed at Johannesburg, South Africa, and Woomera, Australia, in the next three months. As the Canberra, Australia, and Madrid sites are activated, similar recorders will be installed there.

At each station, cost of the updating amounts to $175,000.

"The aim of the updating was not to be able to handle higher information rates, but to handle the same information rates at lower recording speeds and with better recording characteristics," said Karl Johnson, Engineering Group Supervisor, Communications Engineering and operations, JPL. "We will get an eight-to-one decrease in tape usage on *Surveyor* missions, because we can re-

duce speed by a factor of 8. That's going to be pretty significant.

"This is the class of missions where the data rates are very high—mainly lunar missions. But in three or four years even planetary programs will have higher data rates.

"The new recorder system will save no tape on *Mariner* data recording because we still do not have enough capacity on one reel for 10 hours of operation at one DSIF station. We have to use two rolls of tape therefore. Because we run two machines, this still means four reels of tape per station."

In addition to the three main signals, other signals recorded will include synchronization and timing codes, and perhaps a verbal commentary. Seven channels are available for recording in the equipment now being installed. When two *Surveyor* spacecraft are on the Moon at the same time, seven additional channels will be added simply by plugging in more electronic modules and adding seven more channels to the heads on the tape deck.

The main advantage of the FR1400 in this application is that it can record data accurately at low tape speeds of 3¾ in. per sec. (Also it can be sped up to 120 in. per sec. when increased data rate calls for this.)

• **FSM dividend**—Originally JPL asked for a data-packing density on the tape of 1,000 bits per in. for pulse code modulation (PCM) information. The Ampex recorder is capable of better than 2,000 bits per in. at speeds between 3.75 and 120 in. per sec.

This performance is made possible by use of a Frequency-Shift Modulation (FSM) system. Previously, FSM has been used in telegraphy. "But this is the first time to our knowledge," said Allan Purchase, Senior Applications Engineer, Ampex, "that the technique has been used on magnetic tape recorders to give a very reliable PCM recording system at reasonable cost."

Wideband frequency-modulation recording techniques can record PCM data very effectively, but the electronic modules required are relatively expensive.

Standard digital electronics are sometimes used for PCM recording, but Ampex has not used them with the FR1400 because of problems of system integration and excessive crosstalk.

In the FSM electronics that have been adopted, the PCM signal input, represented by two discrete voltage levels, is converted to two discrete frequencies. At 120 in. per sec. the frequencies are 800 kc and 1.2 mc. Since each signal is recorded on the tape for several cycles, there is an increased protection against dropouts.

The digital record-to-reproduce capability is 2,400 bits per in. per track, with no more than 1 bit error in 10^4 bits per digital track. At 1,000 bits per in. packing density, no more than one bit error in 10^5 bits per digital track can be expected.

• **Three systems**—In the recorders supplied to JPL, three types of electronic units give the capability of recording the three main types of signal. Wideband direct electronics enable signals with a bandwidth from 400 cps to 1.6 mc when recorded at 120 in. per sec. Wideband frequency-modulated electronics provide bandwidths extending from dc to 500 kc at 120 in. per sec. Frequency-shift modulation electronics designed specifically for recording PCM can handle rates up to 288,000 bits/sec.

PCM came into extensive use with the *Minuteman* system and has since gained increasing acceptance because of its flexibility, density, reliability and resistance to noise. But Ampex says direct recording of this type of modulation has been limited by amplitude instability and lack of a dc response. These have caused excessive sag in long pulses, variations in effective dc, baseline, and secondary or false peaks in high-density signals. ■

SPACE ELECTRONICS

Lightweight X-Band Radar Proposed As Sensor for Space Intercepts

by Michael Getler

NEW YORK—An X-band radar system, weighing 175 lbs. and reportedly capable of skin tracking an unaugmented one-square-meter target from a distance of 125 miles into ranges less than 200 ft., has been proposed to the Air Force's Space Systems Div. as a sensor for an unmanned space interceptor vehicle.

Because of its close-in tracking capabilities, the interceptor radar is designed to perform both warhead fuzing and hit-assessment functions.

The sensor, developed by General Precision Inc's Aerospace Div., is designed primarily for the satellite intercept mission, but in keeping within the new Standardized Space Guidance System concept (M/R, Sept. 9, p. 16, March 2, p. 17) GPI engineers say both cooperative and non-cooperative rendezvous designs have been completed using a building block approach from the basic design. Rendezvous systems are now being fabricated and are expected to be proposed for AF (OSS), and possibly NASA, space station programs.

• **Based on RS-70 system**—The radar makes major use of Doppler data-processing techniques and components developed by the firm's GPL Div. for the AN/ASQ-28 Doppler navigation system for the RS-70, and of a tri-scan antenna system originally developed for missile guidance applications in work sponsored by the Ballistic Research Laboratory at Aberdeen, Md.

Dr. William Wollenberg, program director at GPI, says the system is designed around proven, state-of-the-art components. He says radar weight is about half that of existing systems having the same characteristics.

The basic system transmitter, according to GPI, uses MOPA (master oscillator power amplifier) techniques in a long pulse system operating at X-band. Manager of Homing Guidance Systems at GPI, Michael McKay, says that this coherent long pulse (of millisecond duration) radar approach, in which the system operates on a 50% on/off duty cycle throughout the mis-

sion, provides the means of achieving the theoretically perfect signal use of CW systems while circumventing the T/R isolation problems associated with CW use.

The transmitter uses a four-cavity klystron output tube with sufficient gain so that it can be driven from a solid-state microwave source. A varactor multiplier chain is used as the exciter/driver unit, putting out in excess of 100 milliwatts. Klystron gain provides a total of 300 watts of transmitted power for the system. Total input power for the sensor is 2 KW.

The high-power operation can be shut down at very close ranges, according to GPI, allowing frequency modulation of the exciter/driver output to perform the close-in ranging functions.

● **How interceptor works**—The basic interceptor radar operates as a narrow-band, coherent, angle-tracking system, according to GPI, which lends itself to developing the range-rate information needed for rendezvous missions and for certain fuzing schemes. Actually, special circuitry is included in the interceptor radar to perform the fuzing functions, with the GPI approach basically one of making close-range measurements a few seconds before intercept by extracting the target echo signal from the wideband portion of the video.

Use of a narrow-band approach up to fuzing reduces clutter problems caused by radar sidelobes or actual beam interception of the Earth in low orbit intercept missions.

The tri-scan antenna used with the system has a 2-3 ft. dish, with actual size dependent upon mission and target spectrum. The antenna is mechanically rotated, but its electronic scan rate is made three times as fast as the mechanical rate through use of a mechanical spinner device. The spinner has three slots, or dipoles, which are rotated at rates between 30 and 100 cps in front of the primary feed to provide a rotating antenna array arrangement. Use of the device has cut down on motor wear and overall antenna complexity for early application.

● **Performance outlined**—GPI engineers claim they have achieved in excess of 45 db isolation with only a 0.9 db insertion loss for the system through use of a solid-state microwave switch in the waveguide portion of the T/R section.

The switch is an intrinsic p-n diode, which is thrown into a conducting state across the waveguide, serving essentially as an electronic T/R tube. The diode reportedly can be switched at speeds in excess of 80 nanoseconds, and can approach speeds of about 30 nanoseconds. The diode protects against receiver saturation in the high-power mode and aids receiver recovery capabilities in the close-in portions of the intercept.

Rapid receiver recovery time is especially important in performing the close-in ranging, fuzing, and hit-assessment functions. The latter capability is based on the radar's ability to track small, interceptor-launched pellets, recording those that pass beyond the target in relation to the total number launched. Improved diodes are expected to close the range gap even more.

GPI engineers say that interceptor radar performance characteristics are quite similar to the non-cooperative radar design. The system yields an S/N ratio of 10 db for typical one-square-meter non-cooperative targets at 100 miles range. Angular accuracy is within 3 mils, according to the firm, with angular rate measurements accurate to within 2 mils/sec and velocity accuracy pegged within 2 ft./sec. Close-in range accuracy is reported as ½% "in the final few miles."

GPI also reports use of silicon integrated circuits in the radar design, primarily in the frequency tracking loop of the Doppler data processing subsystem. GPI is using some in-house-produced devices, but the bulk of the circuits are being supplied by Texas Instruments, Inc. ■

SPACE ELECTRONICS

Gemini Digital Command System Exceeds Reliability Specifications

PHOENIX, ARIZ.—Tests on the digital command system for the two-man *Gemini* spacecraft have shown that under worst conditions the probability that a command from the ground will not be accepted does not exceed one in 100 million.

This well surpasses the mission requirements of a probability of less than 6.7 in one million.

Probability that a command will be accepted incorrectly is much less—about one chance in 2^{150}.

The command system in the spacecraft acts as a backup to manual control of such operations as attitude control. Digital commands transmitted from the ground in the 406-450-mc band can actuate any selection of a number of magnetically latched relays in the spacecraft.

The DCS also accepts data inputs from the ground to the spacecraft computer and updates an electronic timer system.

Supplier of the system, Motorola Military Electronics Division, will provide 22 systems for capsules, plus six test equipments. Total value of the contract, placed by McDonnell Aircraft Corp., is $4.66 million.

Motorola is also supplying the front end of the command system in the *Agena-D* with which the spacecraft will rendezvous. Thirteen production systems for the *Agena* have been ordered.

During the boost phase, the DCS in the *Gemini* serves as a backup guidance system, providing a real-time input to the spacecraft computer. In orbit, the DCS feeds ground-computed orbit data to the spacecraft computer, which maintains a knowledge of the spacecraft's trajectory by conventional navigation equations and predicts touchdown areas.

Commands and data are modulated on the UHF signal from the ground by means of phase-shift keying. An audio tone is phase modulated with binary information and lincarly summed with

another audio tone of half its frequency.

This second tone is used for synchronization. Two Motorola command receivers in parallel-redundant connection receive the UHF carrier in the spacecraft. Outputs from the two receivers are summed and fed to a detector.

Within the detector, an active filter recovers the synchronization and a matched filter detects the digital information. The matched filter is an integrated-and-dump circuit that is clocked by a master oscillator, locked onto the transmitted tone. Oscillator drift is corrected by phase shift within the loop.

Digital bits and synchronization pulses from the detector are routed to a decoder.

In the *Agena* system, the command receivers and sub-bit detector are much the same as in *Gemini*, but the decoder is built by Lockheed.

The *Gemini* decoder can either store data or act on it immediately. A real-time command passes directly to the appropriate relay, without storage. If a computer word or time word transmission is received, the data bits are stored in a shift register. Automatic checking of encryption is then carried out. Properly encrypted message bits pass into an information storage shift register.

On completion of information storage, a ready pulse is transmitted to the computer. During ready pulse time, the computer can retrieve the stored data by sending a clock command. Similarly, the electronic timer subsystems can retrieve a time reference word.

Storage in the shift registers is achieved with three-input flip-flops. If a signal is wrongly encrypted, the system resets and the message sequence is repeated.

The digital command system is made up of seven removable assemblies. Components are soldered to printed circuit boards and encapsulated in modules, each module having a specific electrical function.

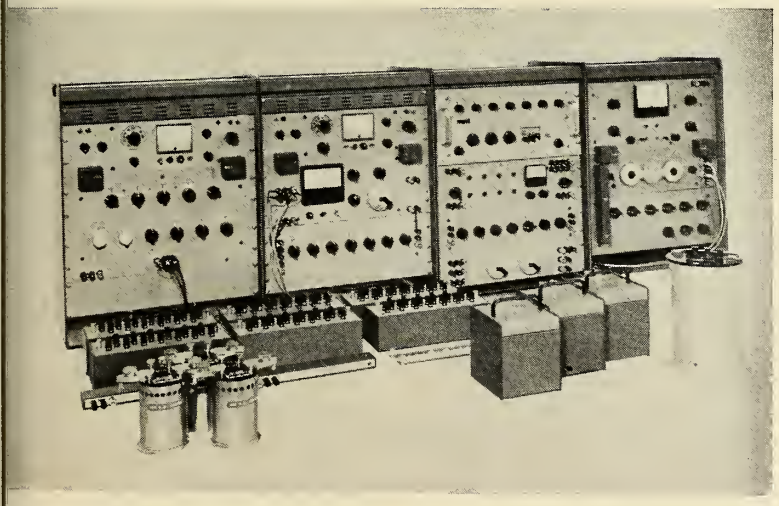
All assemblies are inserted into a housing fitted with an automatic relief valve that prevents breathing of the system caused by small atmospheric changes, but provides pressure equalization when the pressure differential becomes too great.

Included in the ground-test equipment supplied by Motorola is a manually controlled message generator and a tape reader for automatic data insertion. The data are encoded and modulate an RF signal generator coupled to the DCS. All DCS outputs are then monitored for correct response.

A digital command monitor—containing a UHF receiver, decoder and high-speed teleprinter—responds to all command address and prints out messages received. ■

New Product of the Week:

Calibration Console



Electro Scientific Industries has developed the Model 51 calibration console for dc and audio frequency measurements. The unit is designed to use transportable standards for tightest possible traceability to primary standards maintained by the National Bureau of Standards.

Measurement capabilities for the four-system console include: 0.01% direct reading calibration of resistors from 100 milliohms to 120 megohms and comparisons to 1 ppm; 2- and 3-terminal capacitance measurements from 0.0001 picofarad to 1.2 microfarads with 0.01% accuracy and 1 ppm per dial division resolution; ac ratio and voltage division with linearity of ±1 ppm (0.2 ppm with corrections); and potentiometric dc voltage calibration to 10 ppm and up to 1111.110v.

Circle No. 151 on Subscriber Service Card

Thermal Conductivity

An instrument designed to measure the thermal conductivity of metals has been developed by Dynatech Corp.

The axial-rod thermal conductivity instrument, Model TCAG-R8-E, can test a rod specimen ⅜ to ½ in. square x 7-in. long over a range of 5 to 200 BTU-ft./hr.-ft.²-°F. Accuracy over the temperature range of 20° to 800°F is ±2%.

Standard features of the device include: automatic, proportionally-controlled guard heater balance circuits and auxiliary heater, a thermocouple clip for sample instrumentation and a freon refrigeration system. The instrument has an automatic 32°F thermocouple reference system and a voltage-regulated power supply.

Circle No. 152 on Subscriber Service Card

Nuclear Gauge

Numec Instruments and Controls Corp. has available a nuclear varying level detector capable of measuring glass level in a glass furnace forehearth to ±0.001 in.

The system, which utilizes gamma ray transmission techniques, will continuously present a millivolt signal that may be used to control charge rate or to provide a recorder presentation of glass level variation. Recorder noise band is less than 2% full scale.

Circle No. 153 on Subscriber Service Card

Modulator/Demodulator

A radio frequency modulator/demodulator system designed specifically for duplex transmission of vocoder data or digital data over high frequency radio circuits has been announced by Philco Corp.'s Communications and Electronics Div.

The DDM 614 will process 1,200 or 2,400 bits/second vocoder or digital data in a 3-kc voice band. It features 14 data tone channels and quaternary differential coherent phase shift keying.

Circle No. 154 on Subscriber Service Card

Photo Recording System

An integrated high-speed photo recording system, utilizing either Kerr cell or image converter shutter units, is available from Electro-Optical Instruments, Inc.

The Model 70 Fotocord essentially provides a standard structural unit consisting of recording device, focal bellows and lens. Interchangeability of the shutters provide an extensive range of resolution and light gain commensurate with the luminosity of the experiment. Minimum exposure time of the system is five nanosecs and is completely controllable up to 20 microsecs.

Circle No. 155 on Subscriber Service Card

Subcarrier Discriminator

A pulse-averaging subcarrier discriminator, designed for use in frequency multiplex telemetering systems, is available from Sarasota Div. of Electro-Mechanical Research, Inc.

The Model 267A is a solid-state unit with a linearity within 0.1% and output noise less than 0.1% full bandwidth. Center frequencies between 300 cps and 300 kc, with deviations of ±5% to ±40%, are available.

Circle No. 156 on Subscriber Service Card

Carrier Amplifier

A two-channel carrier amplifier system incorporating a master-slave feature is being marketed by Honeywell's Denver Div.

The Model 131-2C has a design change providing for master-slaving two or more carrier amplifiers using only one oscillator. Thus, a voltage of the same frequency and phase can be applied to all transducers. Other features include a ±5-position calibration control for each channel and plug-in cards for calibration resistors.

Circle No. 157 on Subscriber Service Card

Lever Switch

A lever switch designed specifically for electronic equipment and ground-support equipment has been developed by Hurletron, Inc.

The device offers contact ratings from one amp at 50v dc, two amps at 28v dc or 115v ac, and 10 microamps at 10 mv. It is available from one pst through six pdt, momentary or maintained contacts, two- or three-position.

Circle No. 158 on Subscriber Service Card

Wave Generator

A 2-in-1 sine and square wave generator, approximately 1/6th the bulk of comparable instruments, is being marketed by Waveforms, Inc.

The Model 403C provides both sine and square waves in the 1 cycle-to-1mc range. Dial accuracy is ±3% and symmetry of the square wave is maintained to within 1% at all frequencies. Other specifications include: output, 10v into 600 ohms, 1v into 75 ohms; attenuator control down to 100 mv; square wave rise and fall times, less



than 50 nanosecs; short-term frequency stability, 0.005% at 1 kc. The unit measures 8 x 6 x 10½ in. Weight is 12 lbs.

Circle No. 159 on Subscriber Service Card

Frequency Converter

Solid State Electronics Corp. has available a line of "Freqmeters," which will linearly convert frequency or repetition rate of signals to a proportional dc voltage.

The series is comprised of four standard models over an input frequency range from 0 to 100 kilocycles per second. Output is said to be insensitive to supply voltage, temperature, input amplitude or waveforms and will function when driven with sine, square or triangular waves and pulses. No warmup time is required.

Circle No. 160 on Subscriber Service Card

Decade Counter

Janus Control Corp. is marketing an all-silicon decade counter capable of counting at rates in excess of 2.0 mc.

The Model B100-1 has an 8-4-2-1 binary-coded decimal counting technique. It features an arbitrary setting of the output BCD counter levels, making it possible to use the unit with a variety of both standard and nonstandard logic control levels.

Circle No. 161 on Subscriber Service Card

Digital Output Printers

Data Products Corp. is marketing the Series 4000 of buffered line printers, designed to eliminate all adjustment devices.

The unit has a hammer mechanism that eliminates all friction points, pivot mechanisms and mechanical linkages. The paper feed system will accept all standard form weights and numbers of copies without special adjustment. A cabinet completely encloses the printing mechanism and paper storage baskets so operating noise and dust is held to a minmum.

The series is currently available in 600 line/minute speeds. Later, 1,000/minute models will be marketed.

Circle No. 162 on Subscriber Service Card

Filter Manifold

Melabs has developed a directional filter manifold capable of taking an input band between 8.9 and 9.4 gc and dividing it into 16 contiguous output bands.

The Model F-2397 consists of an input waveguide coupled to 16 directional filters, each with a 3-db bandwidth of 31.25 mc. Maximum insertion loss at center frequency is 1.2 db. VSWR is 1.1 maximum in the bandpass and 1.5 maximum at any point on the skirts. Each filter provides 57-db rejection at ±114 mc of center frequency.

Circle No. 163 on Subscriber Service Card

Temperature Transducer

Endevco Corp. is marketing the Model 2245B accelerometer, a high-temperature transducer that operates over a range of −450° to 750°F without need for cooling.

Although optimized as a charge accelerometer, the hermetically sealed unit may be successfully used with either voltage or charge amplifiers. Mounted resonance frequency with mechanical excitation is 30 kc nominal. Frequency response (nominal) is ±5% from a low frequency, established by the asosciated charge amplifier, up to 6,000 cps. Nominal charge sensitivity is 4.0 pk-pcmb/pk-g, and voltage sensitivity with 100 pf external capacity is 18 pk-mv/pk-g.

Circle No. 164 on Subscriber Service Card

Peak-Reading Wattmeter

Bird Electronic Corp. has available the Model 4310 portable peak-reading wattmeter, designed for measurement of pulsed RF systems, such as telemetry, radar and command and control.

The principle of measurement consists of displaying the demodulated envelope on an oscilloscope and biasing the detector to cut-off. Voltage from the variable bias supply is monitored on the meter, which has been calibrated in peak RF power. The unit measures from 50 watts to 10 kw peak power from 2 to 1,260 mc and from 0.1 microsecs pulse width, depending on the element selected.

Circle No. 165 on Subscriber Service Card

Relay Scanner

The Series 3000 scanner, capable of selecting, in sequential order, one to 100 four-wire channels of information, is available from Houston Instrument Corp.

The device can be manually, automatically or remotely operated at up to 100 channels per second and provides isolated printout contact closures for channel identification.

The system is offered with a choice of two scanning contacts. One type is used for signals where up to 70 μv of thermal dc noise and up to 100 μv of common mode noise would have no effect. A second type is used in cases where these noise levels would affect the signal.

Circle No. 166 on Subscriber Service Card

Deviation Meter System

An FM deviation meter system that will measure peak positive or negative deviations of composite wave shapes with better than 2% accuracy has been developed by Advanced Measurement Instruments, Inc.

The Model 1102 enables a carrier frequency range to be read directly within ±0.5% from 20 to 1,000 mc and ±1.0% from 1,000 to 2,500 mc.

The unit is essentially a broadband FM receiver with an ultra-linear discriminator and readout. Deviation is indicated by a linear voltmeter with FSD accuracy within 2%. Five peak deviation ranges are provided: ±10, ±30, ±100, ±300 and ±1,000 kc. Demodulation distortion is less than 0.2%; carrier shift is indicated directly to ±250 kc with 5% accuracy.

Circle No. 167 on Subscriber Service Card

RMS Transformer

Spellman High Voltage Co., Inc., is marketing a high-voltage, oil-filled 20-kv RMS transformer, suitable for use in single-ended or 50-kv doubler circuits at 10 ma.



The hermetically sealed Model HV-20C has an input of 117v, 60 cps. Output is 20 kv RMS. The device measures 7 x 8 x 5¼ in., plus 2¾ in. for HV terminals. Weight is 25 lbs.

Circle No. 168 on Subscriber Service Card

Two-Zone Tubular Furnace

Marshall Products Co. has developed the Model 875-00 two-zone tubular furnace for use in semiconductor or solid-state research.

The window-less unit has two electrically separate temperature zones—one in the 1,200°C range, the other in the 800°C range. A constant temperature zone (±1.0°C) two inches long at 1,000°C is attainable in the center of the first heating zone and another of equal length at 620°C is attainable in the second zone. A maximum distance of 10 in. separates the two flat temperature zones.

Circle No. 169 on Subscriber Service Card

Digital Thermometer

United Systems Corp. is marketing the DigiTec Series 500 digital thermometer, offering a resolution of 0.02% of span.

Model 500 covers a range of 59° to 122°F with an accuracy of ±0.15°F.

Model 501 has a range of 0 to 100°C with ±0.15°C accuracy. It features a fixed span of 20°C (set anywhere between —50° and 150°C) with an accuracy of ±0.1°C. A self-contained probe selector switch permits scanning of four temperature points. Interchangeable probes are available for solids, liquids, gasses or surface-temperature measurements.

Circle No. 170 on Subscriber Service Card

Wave Analyzer

A solid-state wave analyzer, the Model TP-627T, is being marketed by Technical Products Co.

Front panel plug-in units are available for Fourier series analysis, power spectral density and an audio frequency analog. The latter is for automatic amplitude control applications. Dynamic range is 80 db.

Circle No. 171 on Subscriber Service Card

Programming System

A programming system capable of programming and time-coding six independent functions in a missile or satellite has been announced by Logitek, Inc.

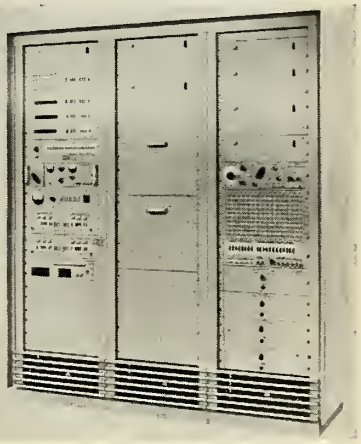
The Model A744 measures 2 x 3 x 3½ in, and includes a solid-state programmer, serial time code generator and field-adjustable six-channel serial decoder. The unit will program any desired time intervals from 0 to 2,047 seconds with outputs in 11-bit digital pulses. Timing accuracy is specified as 0.05% with resolution of 43 millisecs. Stability is rated as 0.017% over a —55° to 125°C temperature range.

Circle No. 172 on Subscriber Service Card

Telemetry Ground Station

A universal pulse-code-modulation telemetry ground station, the Model 1011, has been developed by Monitor Systems, Inc.

The unit accommodates all commonly used waveform codes, including RZ, NRZ-C, NRZ-S, NRZ-M and split



phase, in either polarity with forward or reverse data flow. Word lengths can range from four to 64 bits, fixed or variable, at nominal rates from one to 1,000,000 bps for NRZ and to 500,000 bps for RZ and split phase. Frame lengths range from one to 512 words. The unit has a standard subcommutator ratio of 256:1 maximum with a second ratio optionally available.

Performance is within 1 db of the ideal signal/noise versus error-probability curves, with bit synchronization to —3 db.

Circle No. 173 on Subscriber Service Card

Minimized Autocollimator

Razdow Laboratories, Inc., has developed a minimized automatic tracking autocollimator using an optical link for the measurement of angular rotation rate.

The Mini-Midarm system has an optical unit 6 in. long and 2 in. in dia. When used with a servo follower, the system has an accuracy of ±0.2 arc-second, a sensitivity of ±0.05 arc-second and a repeatability of ±0.1 arc-second over a range of 200 arc-seconds.

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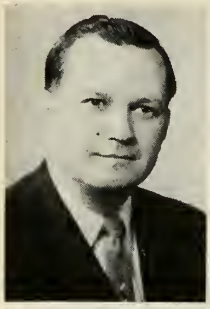
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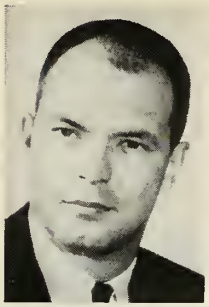
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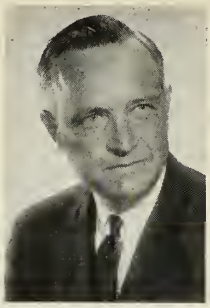
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Carl P. Nierzwicki: Named director of marketing for Motorola Inc.'s Military Electronics Div., Scottsdale, Ariz.

Joseph K. Post: Appointed eastern regional manager-government marketing for Electronic Specialty Co., Washington, D.C.

Dr. Lewis Larmore: Named director of the Douglas Aircraft Co.'s advanced research laboratory, Huntington Beach, Calif.

Edward F. Callanan: Appointed controller of the Aerospace Div. of Clevite Corp., Cleveland. **John W. Watson** named works manager.

Sanford A. Jaffe: Appointed materiel manager at the Romec Facility, Power Equipment Div., Lear Siegler, Inc., Elyria, Ohio.

Vincent F. Villella: Appointed manager of manufacturing engineering for the Stratos Div. of Fairchild Stratos Corp., Bay Shore, N.Y.

David C. Lawton: Named eastern sales manager for Fairchild Controls, Hicksville, N.Y.

Dr. Steward S. Flaschen: Named director-component development for International Telephone and Telegraph Corp., New York City. **Michael J. Samek** named director or marketing and Sales for the Data and Information Systems Div., Paramus, N.J.

R. H. Owen: Appointed vice-president-manufacturing for Aerojet-General Corp., El Monte, Calif.

Roy S. Mushrush: Appointed manager of the Direct Energy Conversion Operation (DECO) of General Electric Co., Lynn Mass.

Samuel J. Losh: Joined Electro-Optical Systems, Inc., Pasadena, Calif., as a senior engineer in program management and systems engineering. **Lloyd M. Hershey** joined the group as a staff engineer.

Ludwig P. Reiche: Appointed manager-communications systems for Stellarmetric, Inc., Santa Barbara, Calif.

Charles J. Feeney: Appointed manager of Philco Corp.'s government planning and marketing staff field office, Boston.

Dr. Robert E. Malm: Appointed director of research and development for Page Communications Engineers, Inc., Washington, D.C.

Chester W. Nimitz, Jr.: Elected executive vice president for operation by Perkin-Elmer Corp., Norwalk, Conn. **Theodore F. Talmage** elected executive vice president for finance and administration.

Arthur C. Stanton: Named vice president-marketing for the Sperry Gyroscope Co., division of Sperry Rand Corp., Great Neck, N. Y.

Lawrence I. Algase: Named director of engineering for Trygon Electronics, Inc., Roosevelt, N.Y.

Herbert L. Antzes: Appointed engineering liaison representative to the Washington, D.C. office of TRW Space Technology Laboratories.

Walter Stubbs: Named manager of quality assurance for Electronic Communications, Inc., St. Petersburg, Fla.

Robert J. Janda: Appointed manager of contracts for the Douglas Missile & Space Systems Div., Santa Monica, Calif. **Beady P. Crass** named field station manager at Vandenberg Air Force Base for the division, and **Henry T. Gibbs** appointed acting resident manager for the Marshall Space Flight Center.

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10th National Aerospace Instrumentation Symposium sponsored by ISA, Biltmore Hotel, New York City, May 4-6.

AIAA Aerospace Propulsion Meeting, Cleveland, May 4-6.

10th Annual Meeting of the American Astronautical Society, Hilton Hotel, New York City, May 4-7.

ASME Metals Engineering Conference, Sheraton-Cadillac Hotel, Detroit, May 4-8

Second National Biomedical Sciences Instrumentation Symposium, Instrument Society of America, University of New Mexico, Albuquerque, May 4-7.

IEEE Fifth National Symposium on Human Factors in Electronics, San Diego, Calif., May 5-6.

Electronic Components Conference, sponsored by IEEE and EIA, Marriott Twin Bridges Motor Hotel, Washington, D.C., May 5-7.

Society for Experimental Stress Analysis Spring Meeting, Hotel Utah and Motor Lodge, Salt Lake City, Utah, May 6-8.

Acoustical Society of America Spring Meeting, Hotel New Yorker, New York City, May 6-9.

COSPAR Seventh Plenary Meeting, Florence, Italy, May 8-20.

International Conference of the Society of Aerospace Photography Engineers and Technicians, Palisades Park, N.J., May 10-15.

16th Annual National Aerospace Electronics Conference (NAECON), IEEE and Dayton Section of the AIAA, Biltmore Hotel, Dayton, Ohio, May 11-14.

Symposium on Applied Mathematics and Mechanics in honor of Theodore von Karman, sponsored by AF Office of Scientific Research and the Society for Industrial and Applied Mathematics, Shoreham Hotel, Washington, D.C., May 11-14.

35th Annual Scientific Meeting, Aerospace Medical Association, Americana Hotel, Miami Beach, Fla., May 11-14.

ASME 1964 Design Engineering Conference, McCormick Place, Chicago, May 11-14.

Plastics and Adhesives in the Space Age, Regional Technical Conference, Society of Plastics Engineers, Garden City Hotel, Garden City, N.Y., May 13-14.

IEEE International Symposium on Microwave Theory and Techniques, Kennedy International Airport, New York, May 19-21.

Space and Defense Procurement Briefing Conference, sponsored by Federal Bar Association and Bureau of National Affairs, Sheraton Hotel, Houston, May 20-21.

Seventh National Symposium, "Adhesives and Elastomers for Environmental Extremes," Society of Aerospace Material and Process Engineers, Los Angeles, May 20-22.

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The Day He Dies

TO WRITE ABOUT DISARMAMENT on behalf of this industry may be an exercise in futility. It may be that we are too plainly tagged, as an industry, with the "merchant of death" label to be regarded as objective about the question.

But there is such a feeling abroad in the land that the Cold War is thawing, there is so much talk of amity with the Russians, there is so much discussion of conversion of the defense industry to civilian pursuits, that someone must speak out. We intend to do so, despite the possible charge that we hold a prejudiced viewpoint.

Few serious planners in this industry anticipate any sharp reductions in the defense budget between now and 1970. Yet so widespread has talk of disarmament become that the Pentagon found it necessary to issue a denial recently that sharp cuts could be expected in defense spending.

What has brought on this new atmosphere, so dubious with regard to defense? First and foremost, perhaps, was the confrontation of the two major powers in the Cuban missile crisis in October, 1962. On both sides, governments and citizens were face-to-face with the frightening possibility of nuclear war. Although the crisis is now past, it is not surprising that revulsion at the horror of nuclear weapons carries over.

This is evident in the test-ban treaty and in the recent joint announcement of a reduction in the output of materials for nuclear weapons. It also is evident in the increased desire of citizens of both the U.S. and the Soviet Union to be free of the nuclear Sword of Damocles.

Here is what a Deputy Asst. Secretary of Defense has had to say within the past 12 months on the subject of arms control:

"A disarmed world subject to the rule of law is one of the objectives of U.S. foreign policy. I must confess I am an optimist. I believe this objective can be achieved. It will not be achieved overnight but by evolutionary means providing we keep it before us. . . .

"On January 6, 1961, Nikita Khrushchev, in an historic speech, outlined the strategy of the Soviet Union. In this famous speech he made it clear that the Soviet leadership does not believe that thermonuclear war or large-scale aggression can serve the interests of the Soviet Union. This recognition represents an historic turning point in the post-war period for if the Soviet Union follows this policy, it will represent a limited victory not only for the free world but all mankind."

And this is what Nikita Khrushchev himself had to say as recently as April 20:

"It is the profound belief of the Soviet government that the efforts must be redoubled in searching for a solution of the main problems of disarmament, in adopting more and more effective measures of strengthening universal peace. This is demanded by the vital interests of all states, all peoples."

We would like to raise the question of what has brought us to this period of détente, this period of live-and-let-live in which the Russians declare that universal peace is demanded by the vital interests of all states.

More than anything else, it has been the overwhelming nuclear deterrent of the United States. In three words, the Strategic Air Command. Since the end of World War II, the B-36's, B-47's, B-52's, B-58's and the intercontinental missiles of SAC have kept the uneasy peace between the U.S. and the Soviet Union.

But more than the dedication of SAC has been required. Also necessary to the effectiveness of the deterrent has been the presence of a man on the Soviet side shrewd enough to appreciate the meaning of its existence.

A few days ago, the rumor of Mr. Khrushchev's death made headlines around the world. The rumor was false but the importance attached to it is a significant clue to the effect that the event will have.

The Russian premier is a shrewd, extremely able leader. He has gone tremendously far in removing the shackles of the Stalinist era from the Soviet people. He has improved their standard of living and he has, in large part, lifted the fear of the knock on the door in the night from the Soviet citizen. More than any one man, he has changed communism. And he has seen, perhaps more quickly than our own politicians, the implications of the nuclear stalemate. SAC, ironically, is more appreciated in Russia than in its own land.

BUT MAKE NO MISTAKE, Chairman Khrushchev has done nothing to lessen the desire of the Soviets to be the leading nation in the world. As Hegel has suggested, self-interest still is the highest law governing the relation of one state to another.

Under the duress of SAC, Mr. Khrushchev has been the man who has brought about the present Cold War thaw. That the effect of his passing will be profound is inevitable. The internal reaction—that his successor will take a less reasonable position from the U.S. viewpoint—is equally inevitable. Never will there be a return to the Stalinist days—that now is impossible—but the pendulum will swing back.

The desire for peace has been universal since the days when the Romans enforced the Pax Romana. Sybaritic living then destroyed their will to fight and the barbarians fell upon them. Whether sparked by a desire for peace or by a desire for "living it up," disarmament has never been a satisfactory answer.

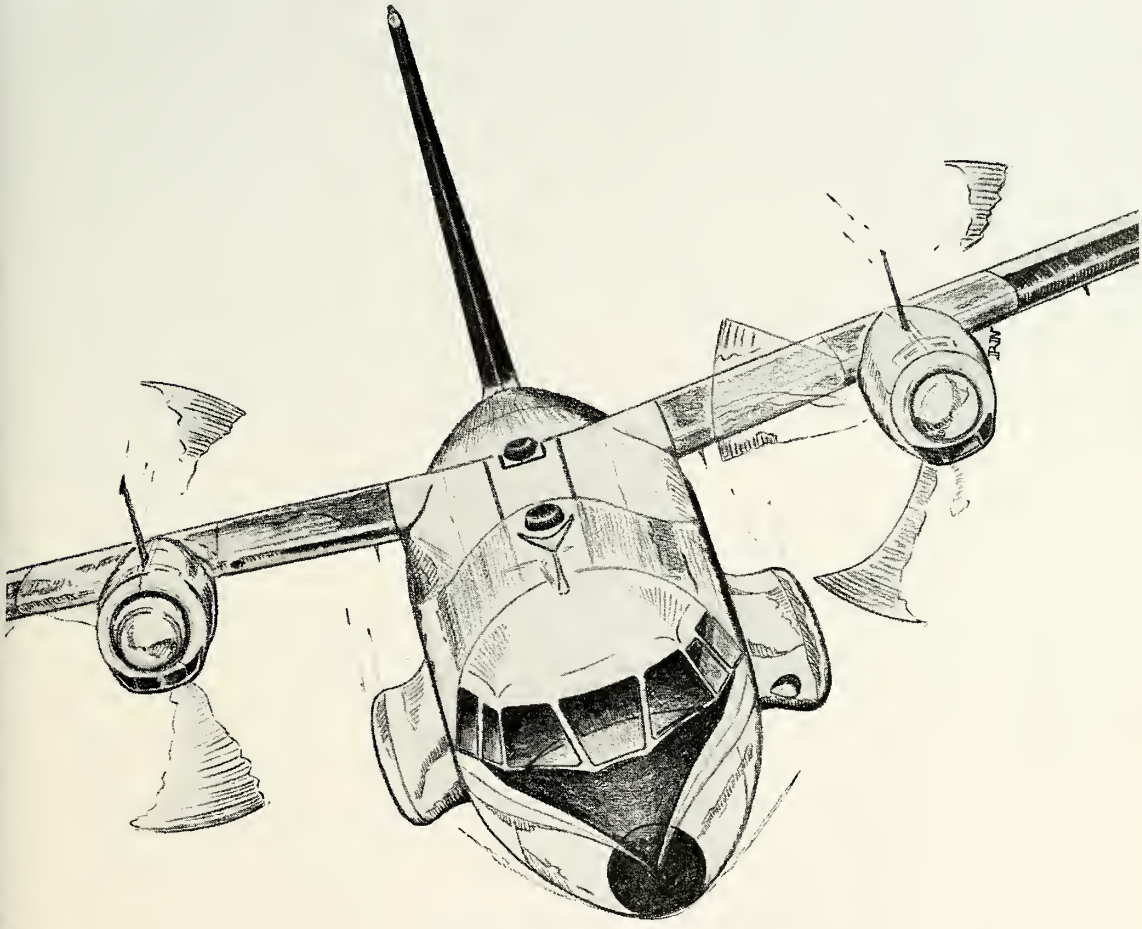
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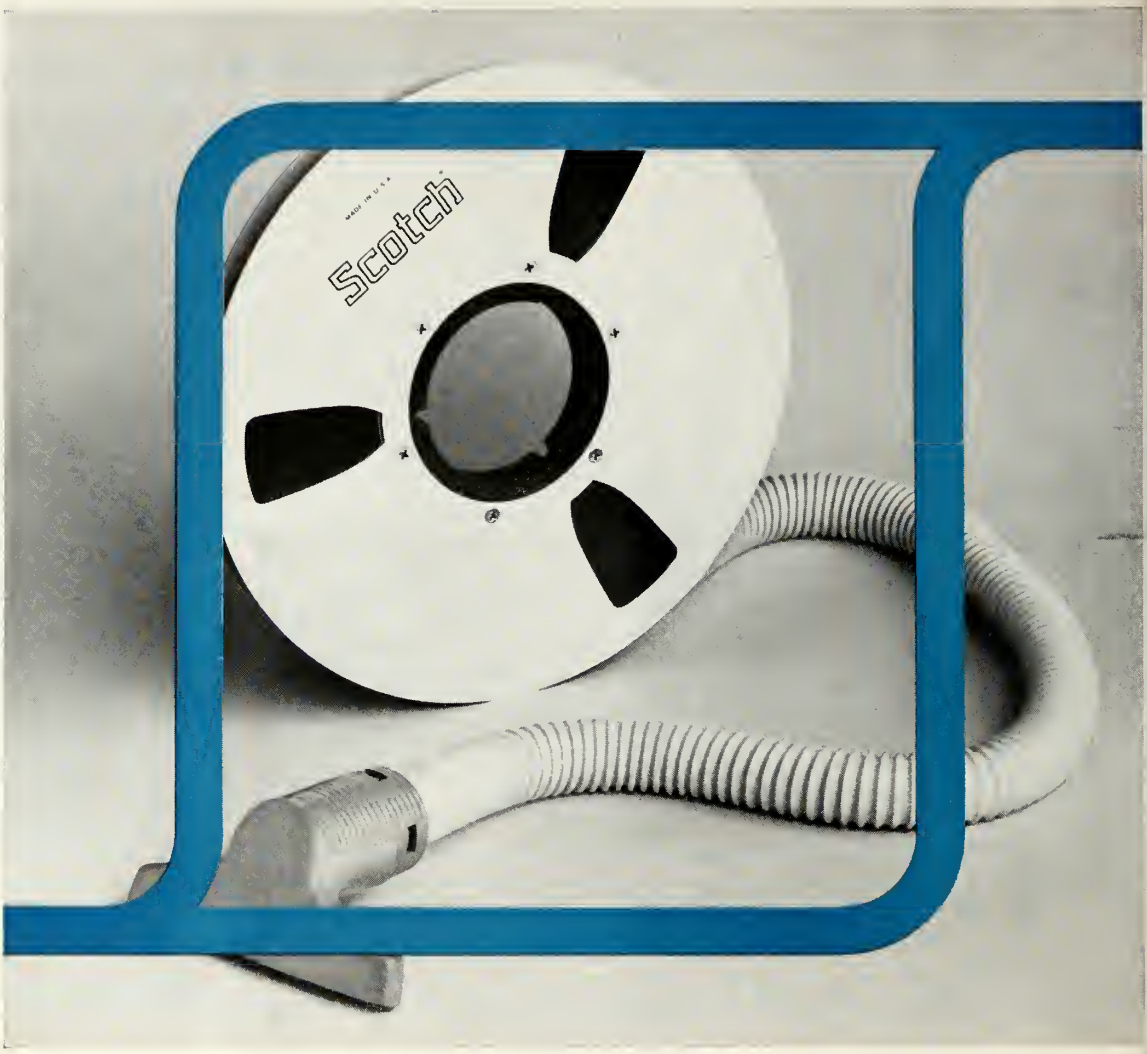
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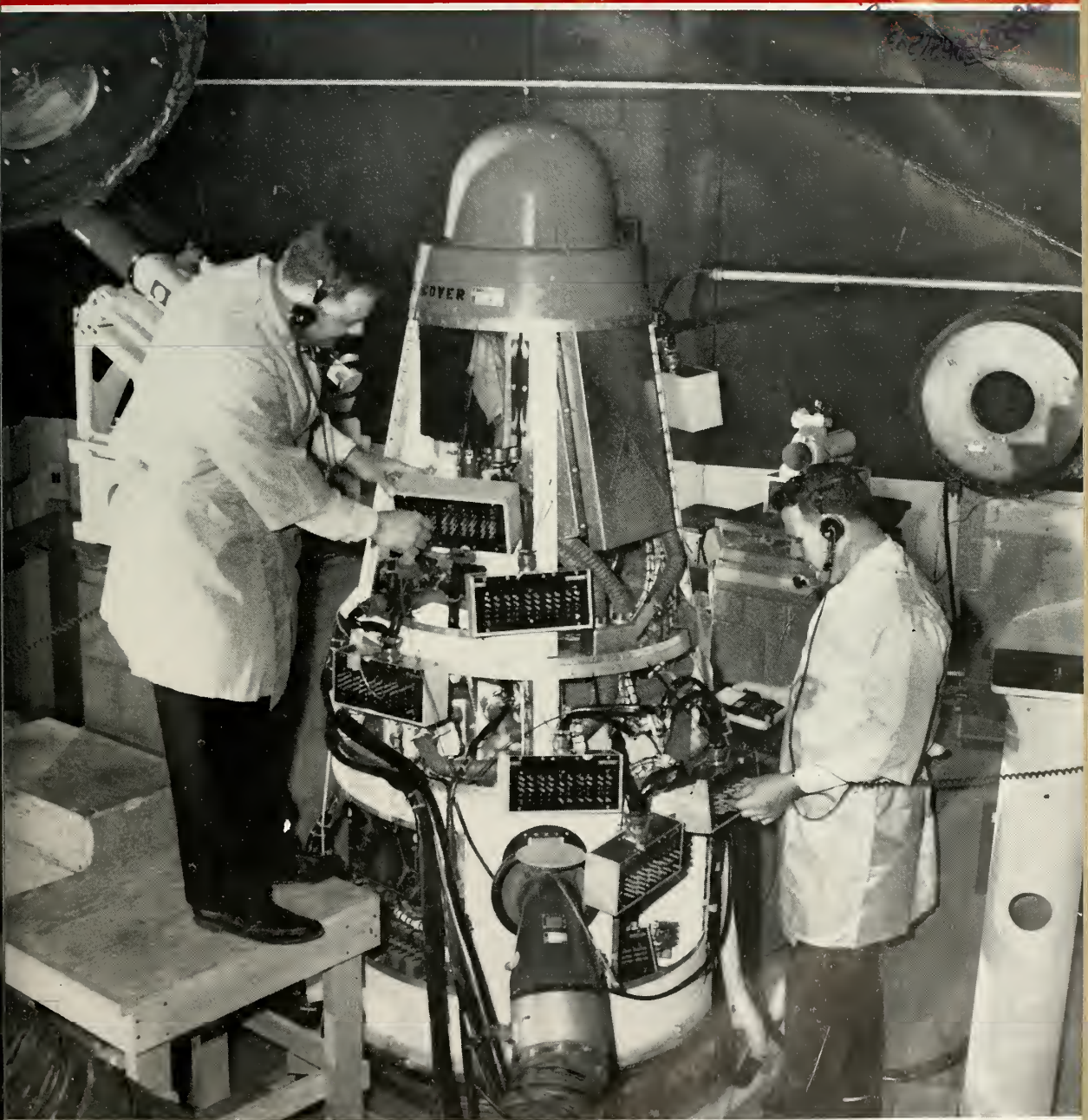
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MAY 11, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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GPI Readies Guidance for STAFF Flight

U.S. Developing Anti-Satellite Weapon . .

AF To Award Studies of 3-Module MOL .

Latest Edition of M/R's Astrolog . . . . . .

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 14, Number 19 May 11, 1964

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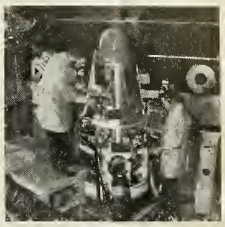
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THE COVER



Technicians from General Precision's Aerospace Systems Div. make final adjustments to stellar inertial guidance equipment in special test vehicle to be used in AF's Stellar Acquisition Flight Feasibility (STAFF) program. General Precision is prime contractor for the special test system and an associate contractor with Lockheed Aircraft Co. for flight testing. *See story p. 9.*

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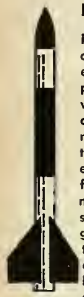
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Creativity Penalized

To the Editor:

Surprisingly I have found no mention in M/R of elsewhere-reported news concerning the passage by the House of the Celler bill (HR-8190) for increasing present and adding new maintenance fees for patents; predicted also is favorable action by the Senate on these highly controversial proposals, which the Department of Commerce itself untypically defends in current hearings by the Senate Subcommittee on Patents, etc.

The Patent Office, perennial Cinderella among our government's family of agencies as to appropriations, yet the very fountainhead of our technological economy, would be required to drain the pockets of our independent and small-business inventors, to provide urgently needed funds which Congress has failed to provide.

Already frustrated and reduced to a mere 30% of our patentees, these impoverished creators of our great industries can only be further decimated by the imposition of these new fees. Wholly unorganized, they have no mass voice of protest. Those inventors who have already been driven into corporate and governmental employ couldn't care less because they, by their patent-assignment employment contracts, are stripped of their patent rights as well as even a small "piece of the action" these produce. No more than plantation slaves of old dare they now protest these new fees or the taking-over of the products of their creativity.

Rather than hurtful for the big fellows, this proposed legislation would undoubtedly be beneficial, since it could only still further corral the independents into their domains, where their creative activities are so controlled that no disrupting developments of theirs could threaten their status quo. The effect of such complete control could be just as bad as the price-fixing variety uprooted by the Department of Justice a few years ago.

Other than mere subsistence wages, the employed inventors have no incentives to invent. That they do not is clear because our annual patent has been static at around 50,000 or lower for thirty years. Contrarywise, European countries, including the Soviets, have annual patent rates per million of population exceeding ours by factors of 3 to 10 and more, due to laws which wisely encourage and realistically reward invention. But here, with a doubled population, astronomically increased R&D expenditures, and tremendous increases in technically qualified, potential inventors, it is we who should vastly exceed the foreign rates.

It will be a sad day when all of our independent creative thinkers in Science and Technology have been exterminated or controlled; with only 30% now remaining, and with such legislation as HR-8190 in the offing, that day is not far distant. Other straws in the wind portend a national policy, only too familiar among politicians, now shaping up in the cold war: "If you can't lick 'em, join 'em!"

B. F. Miessner
Miami Shores, Fla.

Axial Combustion Instability

To the Editor:

Although the article on SRI investigations of combustion instability (M/R, March 9, p. 36) lacks detail, it seems clear that the mode of oscillation under discussion is axial as opposed to transverse. Mr. Lionel Dickinson of SRI was quoted at some length on the matter of stability limits, their determination, the influence of propellant composition, and test methods for "checking the presence of incipient instability in any solid propellant/motor combination." Your readers can obtain a detailed description of axial combustion instability in open-literature reports of an experimental investigation undertaken at the Canadian Armament Research and Development Establishment (CARDE), Valcartier, Quebec.

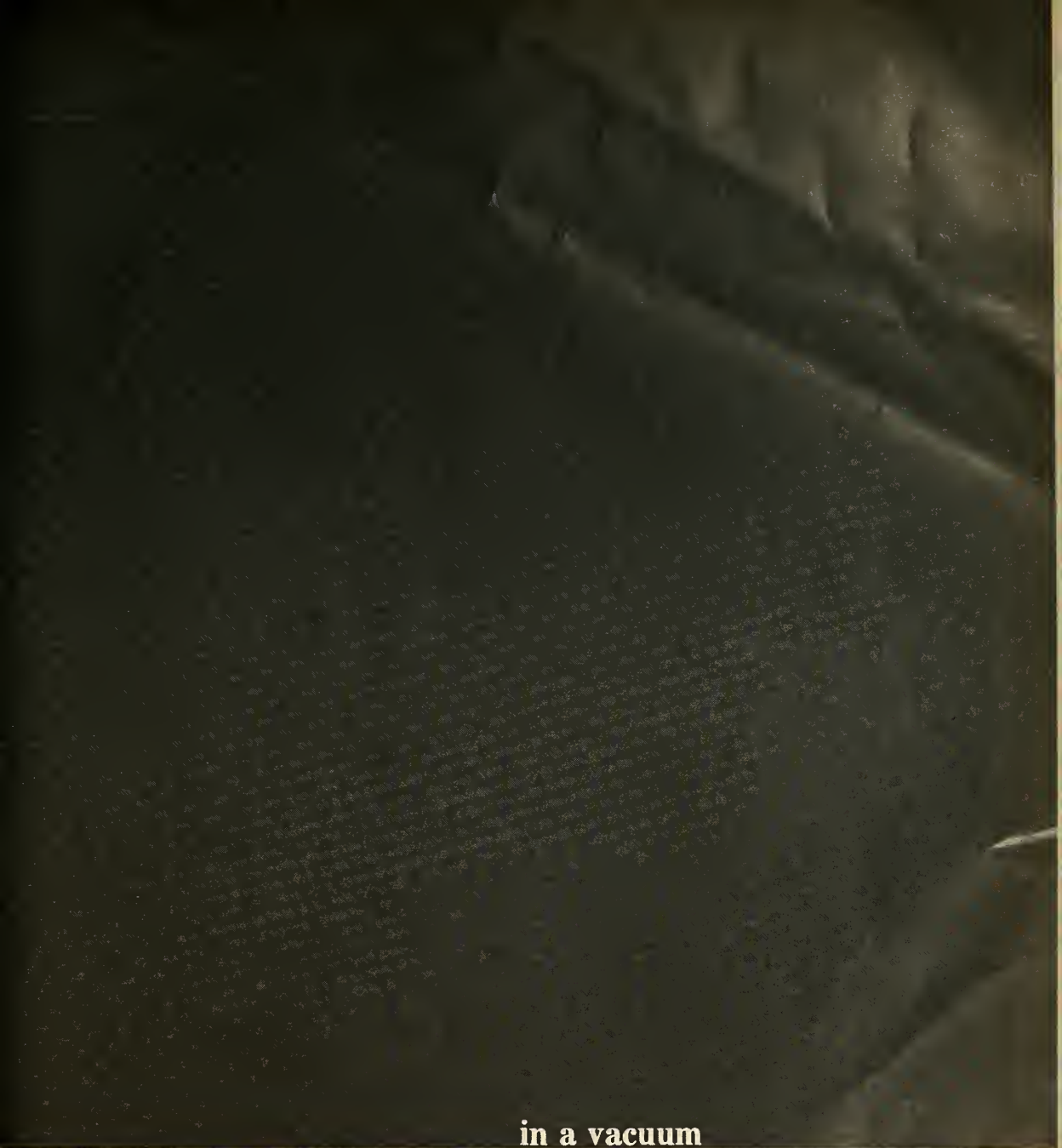
Maj. W. G. Brownlee, RCA, began a detailed study at CARDE in 1960, at which time Mr. Dickinson was Head of the Rocket Engine Development Section. The program continued after Mr. Dickinson's resignation in 1962 and remains active. A phenomenological description was presented at the AIAA Summer Meeting 1963 (AIAA Preprint No. 63-228) and published in the AIAA Journal (February 1964, Vol. 2, No. 2, pp 275-284) with the title "Nonlinear Axial Combustion Instability in Solid Propellant Motors" by W. G. Brownlee. This paper describes nonlinear excitation, a pulse-injection method of testing motors (originally conceived by Mr. Dickinson), the behavior of fully excited motors, a method of determining stability limits using relatively small motors, and the influence of certain aluminum additives as well as a burning rate decelerator (LiF).

A second paper presented at the Ninth Anglo-American Conference (Boston, October 1963, AIAA Preprint No. 63-474) "Investigations of Nonlinear Axial Combustion Instability in Solid Propellant Rocket Motors" by W. G. Brownlee and A. K. Roberts describes the effect of varying the binder and aluminum levels and of incorporating copper chromite as a burning rate accelerator.

The feasibility of "tailoring" propellant formulations in order to obtain improved stability characteristics at given operating conditions was noted in the latter paper and is being used to advantage in current CARDE development programs.

I. R. Cameron
Superintendent
Propulsion Wing
Canadian Armament Research & Development Establishment
Quebec, P. Q.
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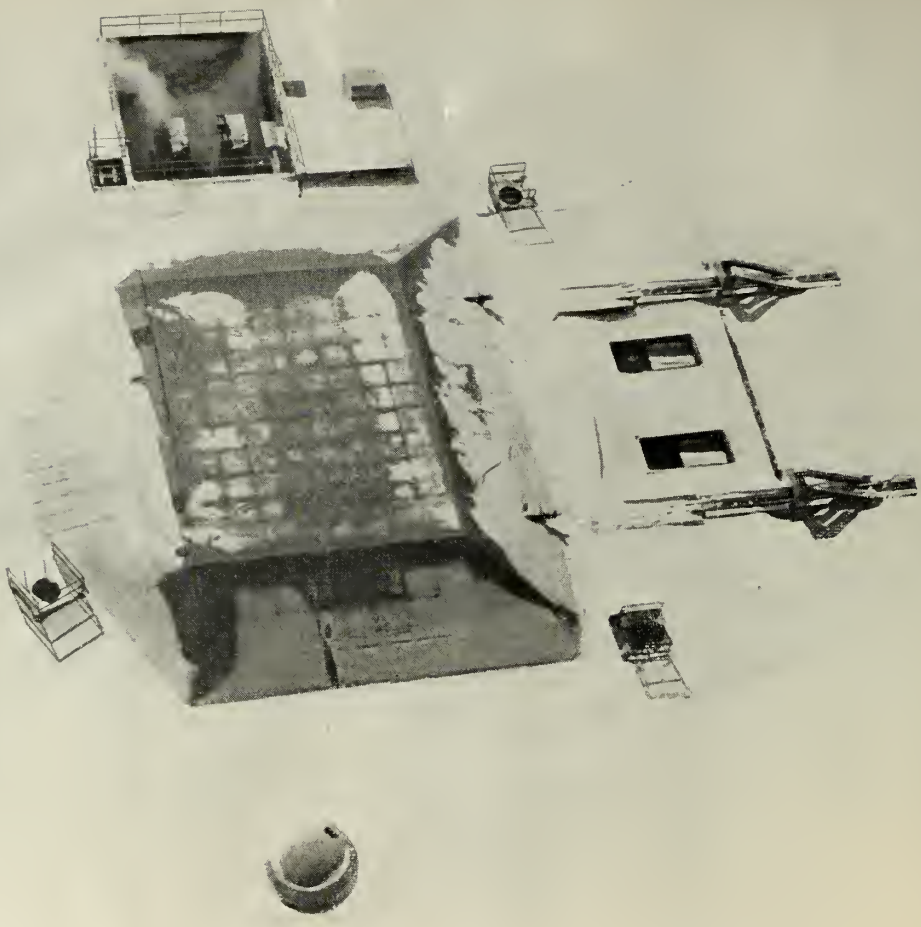
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The Countdown

WASHINGTON

LBJ Space Plans Demand Unexplained

There is still no White House comment on the purpose of President Johnson's recent request for a comprehensive report on NASA's post-*Apollo* plans (M/R, May 4, p. 12). Speculation is that the report will be submitted to Congress after it is coordinated with data from other agencies. There also are reports that the President may use it during the election campaign—perhaps as a statement of new space goals or a plea for U.S.-USSR cooperation in future programs.

Apollo Escape System Due for Tougher Test . . .

Tuesday, May 12, has been set as the launch date for the next test of the *Apollo* spacecraft launch escape system. It is the first test of the system under high dynamic pressure. *Little Joe II* will be used to boost the *Apollo* boilerplate command and service modules from White Sands Missile Range, N.M.

. . . And Service Module Propulsion Sputters

Combustion instability is plaguing the *Apollo* service module's propulsion system. Officials hope the problem can be cured with a new "baffled injector." They say they'll decide by May 31 whether this is the answer.

Athena Set for Second Try

May 14 is the scheduled date for the Air Force's new attempt to fire the *Athena* from Green River, Utah, into White Sands. The first shot in February ended unhappily when the missile deviated 50-75 mi. off course and landed 20 mi. from Durango, Colo. *Athena* is part of the Air Force's Advanced Ballistic Re-entry Systems (ABRES) program.

ComSat Corp., DOD Still Negotiating

The deadline which Deputy Director of Defense Research and Engineering Dr. Eugene G. Fubini set for himself for "agreeing to agree or agreeing to disagree" with the Communications Satellite Corp. has passed with no agreement to do either. Fubini had estimated that negotiations between DOD and the corporation on defense use of the civilian system would have reached a stage by April 30 at which a determination could be made. But the talks are still going on —with the main stumbling block still the degree of communications invulnerability ComSat is willing to give DOD.

TOW Suffering Growing Pains

TOW—the Army's latest antitank, wire-guided missile—is having what Army officials term normal development difficulties. In test firings at Redstone Arsenal, the troubles have come in getting the in-flight motor to ignite. There have also been some wire failures, but this is considered less critical than the motor problem.

Big Surveyor Booster Choice Approaches

The space agency expects to decide around Sept. 1 whether the FLOXed *Atlas* or the *Titan III* core will be used to launch the heavy (2,500-2,800 lbs.) *Surveyor* spacecraft in 1967. Originally, Martin Marietta proposed mating the *Centaur* to the *Titan II* for the launches; NASA said that would be too costly. Using the *Titan III* core—the first two stages minus the 120-in. solid strap-ons and the transtage—is less expensive, because much of the needed structural strengthening has already been done in preparation for affixing the strap-ons.

Semper Paratus

The crying-towel protests of JPL and NASA that Congressional investigation of the *Ranger VI* failure would seriously damage morale of the project team may have an aftermath. In the event of a *Ranger VII* failure, the House Space Committee now can be cited as one of the guilty parties on a "we told you so" basis.

INDUSTRY

GD/A Choice of MOL Teammates May Startle

There are reports within industry that General Dynamics/Astronautics is preparing to announce a "surprising" partnership for the competition to win the Air Force's *Manned Orbiting Laboratory* contract.

Mueller Cites Apollo Weight Margin . . .

Despite rumors that North American has submitted a proposal to NASA to "completely re-do the *Apollo* program due to an overweight problem," a top NASA official says there's still room to maneuver. Manned spaceflight boss George Mueller told M/R "There is presently a 4,000-lb. margin of safety." Noting that the requirement is to send 90,000 lbs. to escape, he said that "with a project this size, and since 15% of the LEM vehicle still has to be design-frozen, we can expect some growth in weight." In addition, he said that even though the command and service modules are said to be frozen already, "in R&D nothing is ever frozen entirely; we may get some weight additions."

. . . And Titan III-C Excess Is Minimized

Titan III-C has suffered a 200-lb. payload loss as a result of overdesign of the core skirt that supports the booster on the pad. Spokesmen said it was impossible to cut the added weight without extensive re-design of the vehicle. A top source said, however, that in view of the contingency factor of about 2,000 lbs. in the *MOL*, this was not considered a problem. He added: "We are highly pleased with what has been accomplished. We reached higher specific impulse and greater total thrust than contracted for, the liquid thrust vector control system has achieved nine degrees of freedom instead of the planned six, and we have nearly 100% excess TVC capability."

INTERNATIONAL

British To Use Own Polaris Warheads

The agreement for British purchase of *Polaris* missiles does not extend to the warheads, which according to law must remain under U.S. control. Britain will develop its own warheads, says the Secretary of the Royal Navy. U.K. officials have already visited the United States to discuss their nuclear warhead development program.

Titan-like ELDO Nears Firing

The half-scale ELDO booster mockup shown at the Hanover Air Show would be a dead ringer for a *Titan I*. First stage of the genuine article is now slated for a test firing "late in May." But as an ELDO official put it: With our program, it isn't the month which is important—it's the year."

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ComSat Stock Sale Set

Five million shares of Communications Satellite Corp. common stock, plus any shares not subscribed for by that date by FCC-authorized common carriers, are due to go on sale May 26 through 11 managing underwriters. Cost will be $20 a share. Final approval of the sale by the Securities and Exchange Commission is expected shortly.

A preliminary prospectus issued by ComSat on May 6 provides potential shareholders a comprehensive explanation of the unique venture and its risks.

Named as managing underwriters are: Merrill Lynch, Pierce, Fenner & Smith; Blyth & Co.; First Boston Corp.; Kidder, Peabody & Co.; Kuhn, Loeb & Co.; Lazard Freres & Co.; Lehman Bros.; Carl M. Loeb, Rhoades & Co.; Paine, Webber, Jackson & Curtis; White, Weld & Co.; and Dean Witter & Co.

Estimated costs of development and establishment of the ComSat system, less any maintenance system costs, will be in the range of $190-230 million, according to the preliminary prospectus. Should ComSat and the Dept. of Defense come to agreement on DOD use of a random system the cost would be "substantially greater."

Range Division Set Up

Organization of the National Range Division under the command of Maj. Gen. Leighton I. Davis was announced last week by the Air Force Systems Command. NRD headquarters will be located at Andrews AFB, Md. However, the main body of the Division headquarters will be organized as Detachment 1, HQ., NRD at Patrick AFB, Fla.

At Andrews, Gen. Davis will serve in two capacities: Commander, NRD, and Deputy Commander, AFSC, for Global Range. In the second capacity, his headquarters at Andrews will enable him "to fully use the Headquarters, AFSC, staff," the Air Force said.

The National Range Division i responsible for planning, operating developing, maintaining and control ling assigned Defense Dept. rang facilities. Gen. Davis also has bee assigned responsibility for the inte grated use and development of th Satellite Control Facility at Sunny vale, Calif., which operates the DOI satellite tracking and control facili ties.

Under the NRD, the Air Forc Missile Test Center at Patrick AFB Fla., becomes the AF Eastern Tes Range (ETR) and the Air Forc Space Test Center (Provisional) Vandenberg AFB, Calif. becomes th AF Western Test Range (WTR) Detachment 2 of NRD will be estab lished at Space Systems Div. for sup port of missile and space R&D pro grams.

McNamara Discusses Defense

There is no possibility that the Soviet Union could achieve an effec tive ballistic missile defense system within the next five to seven years Secretary of Defense Robert S McNamara told the Advertising Council of America in one of his rare public speeches.

To protect 35% of the U.S. popu lation with an anti-ballistic missile defense system would cost $15-17 billion, with $2 billion additional for operations and maintenance. A sim ilar system would cost the Soviets considerably more, McNamara con tended, because of the greater dis persion of that country's population.

The Defense Secretary also made the point that he saw no possibility of the introduction of Earth-orbiting weapons, particularly high-yield nu clear bombs, in the next five years.

McNamara also predicted that lasers as military weapons, if at all possible, are "far in the future."

In a wide-ranging speech, the De fense Secretary commented that:

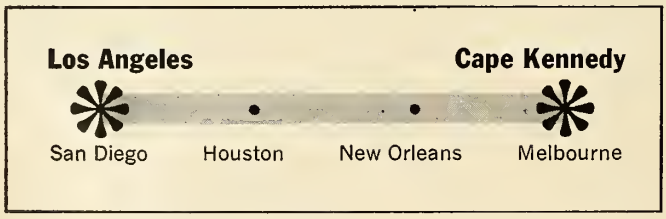
—U.S. nuclear-armed antisub marine forces would be able to pro tect U.S. shipping during war time.

—American military strength, both nuclear and conventional, will continue to increase, but at a slower rate.

DOD Denies Missile Pullout

The Dept. of Defense has denied it has intelligence that would sub stantiate recent published reports

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that Russia withdrew its more advanced anti-aircraft missiles from Cuba two or three months ago when Soviet troops were leaving the island.

A DOD statement said the department had "no information indicating any change in the characteristics of the ground-to-air missiles installed in Cuba, despite published reports."

McConnell New AF Deputy

Gen. John P. McConnell has been named by President Johnson as Air Force Vice Chief of Staff, effective July 31. Currently deputy commander of the European Command, McConnell will replace retiring Gen. William F. McKee.

The move makes McConnell the apparent successor to Air Force Chief of Staff Curtis E. LeMay, scheduled to vacate the post in February.

Hitch Defends DOD Method

Assistant Secretary of Defense Charles J. Hitch, in a talk before the Military Operations Research Symposium in Washington, defended cost/effectiveness studies against charges that they put consideration of the dollar before national security.

"Extensive use in defense decision making of systems analysis or cost/effectiveness studies still engenders considerable controversy," Hitch said. "It is something of a mystery to us why this is so. In a way, it is quite ironic that the very people who are so insistent that they want the 'best and most modern' in defense hardware are opposed to the 'best and most modern' in defense analysis and decision making techniques."

Hitch deplored the widely held conviction "that it is somehow sinful, or at least unpatriotic, to try to relate performance or military effectiveness to costs—that consideration of military effectiveness and cost are antithetical."

NASA Gets $52M Restoration

The Senate Aeronautical and Space Sciences Committee has restored $52 million of the reductions made by the House in NASA's Fiscal Year 1965 budget request.

The amount is almost exactly half the difference between the agency request and the authorization granted by the House. Details of the action will be disclosed this week after another meeting of the Senate space committee, in which the language of the report explaining the actions will be worked out.

However, it is believed that the Senate space committee has upheld additions in propulsion funding ($3 million for high-energy liquid, and $1 million for advanced solid propellent work), and cuts in some of the space sciences programs. It is also known (M/R, April 20, p. 9) that the Senate space committee has taken a hard look at the timing of some of the unmanned probes and may have made further cuts in these.

STAFF Vehicle Flight Set

The first *Stellar Acquisition Flight Feasibility* special test vehicle (cover picture) will be flown from Cape Kennedy this summer. Launched by *Polaris A-1* missiles, the *STAFF* vehicles, will provide data on the stellar inertial guidance of a ballistic missile during boost and mid-course phases of trajectory.

Four *STAFF* launches are planned. Originally, the stellar system was earmarked for the *Mobile Medium Range Ballistic Missile.* However, development of *MMRBM* is not assured unless Congress restores $70 million cut from the FY '65 budget. Recently, DOD has widened the range of application of the Stellar Inertial Guidance System (STINGS) to include its application to the Precision Orbit and Recovery Program. Congress earmarked $40 million of *MMRBM* funds specifically for the development of STINGS.

Scientists To Be Astronauts

NASA will select a group of 40 to 50 scientists to undertake a training program that will prepare them to accompany astronauts on flights during Project *Apollo.*

According to Dr. Hugh L. Dryden, deputy administrator, the selection will be announced in about three months.

The program will probably call for the reserve pool of scientist/astronauts to undergo an annual training session, much like the national reserve program.

The NASA official said that the Space Science Board of the National Academy of Sciences is in the process of setting up the qualifications for the group. Prerequisites for consideration would be a Ph.D. degree in the physical sciences and some degree of flight experience.

NASA said that a scientist definitely would not go along on the first manned lunar landing.



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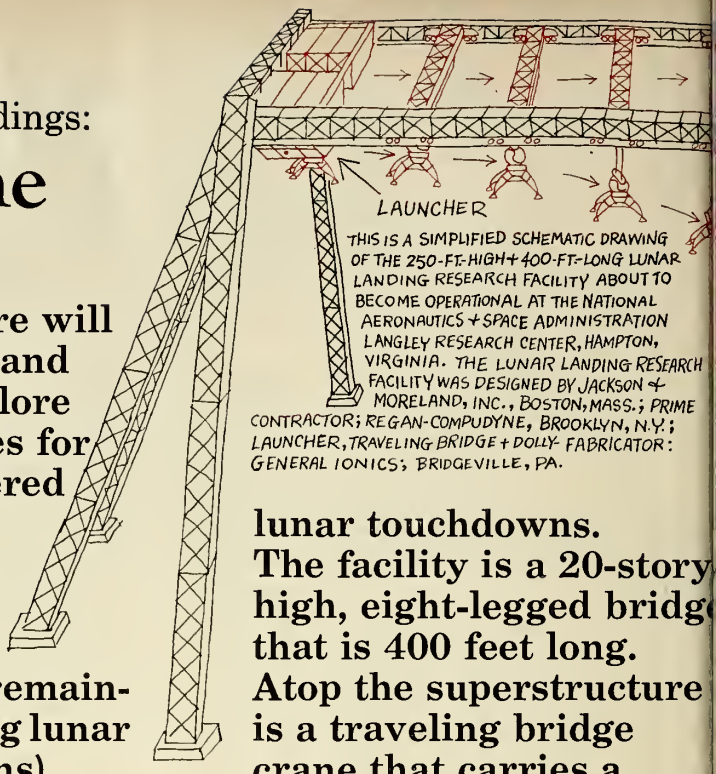
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Research on Lunar Landings:

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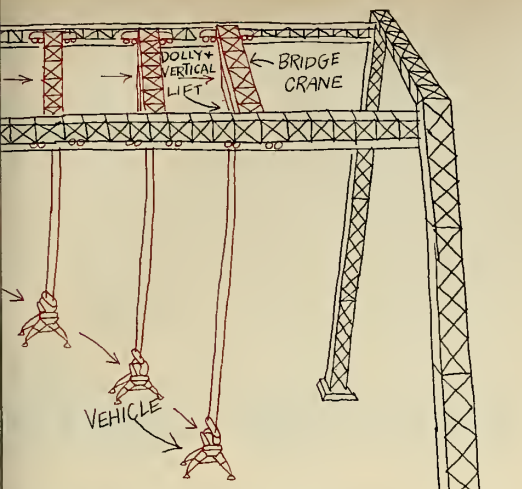


THIS IS A SIMPLIFIED SCHEMATIC DRAWING OF THE 250-FT.-HIGH + 400-FT.-LONG LUNAR LANDING RESEARCH FACILITY ABOUT TO BECOME OPERATIONAL AT THE NATIONAL AERONAUTICS + SPACE ADMINISTRATION LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA. THE LUNAR LANDING RESEARCH FACILITY WAS DESIGNED BY JACKSON & MORELAND, INC., BOSTON, MASS.; PRIME CONTRACTOR; REGAN-COMPUDYNE, BROOKLYN, N.Y.; LAUNCHER, TRAVELING BRIDGE + DOLLY FABRICATOR: GENERAL IONICS; BRIDGEVILLE, PA.

The facility shown here will help NASA scientists and research pilots to explore and develop techniques for landing a rocket-powered vehicle on the moon. The special crane will support five-sixths of the weight of the research vehicle. The remaining one-sixth (matching lunar gravitational conditions) will be supported by the craft's hydrogen peroxide rocket system. During research flights the crane system will be slaved to move with the vehicle's linear motions, to keep the cables vertical. A series of special pivots called gimbals will permit the vehicle to pitch, roll and yaw under its own power. In short, the moon's gravity will be effectively reproduced over a Virginia field.

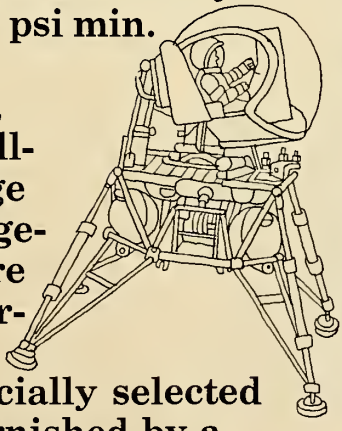
Research pilots will have three minutes to land in the target area. Repeated tests of every conceivable landing approach will enable NASA to formulate methods for lunar touchdowns. The facility is a 20-story high, eight-legged bridge that is 400 feet long. Atop the superstructure is a traveling bridge crane that carries a special lateral-moving dolly from which hangs the lunar research vehicle. In the first phase of the research program, velocities will be generated by the vehicle without the aid of a catapult. The second phase will involve a catapult that will permit test velocities of up to 50 ft./sec. horizontally and 40 ft./sec. vertically during the first 100 feet of travel.

To decelerate prior to landing, the research pilot can make use of two main motors capable of developing 6,000 pounds of thrust. Jackson & Moreland, the designers of the structure,



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At Johnston Island site . . .

Non-Nuclear Anti-Satellite Syste

Development program will use Agena D's boosted by modified Thors; project called insurance against treaty violations

USING THE JUSTIFICATION that it is fulfilling its commitments under the Nuclear Test Ban Treaty, the Administration is actively developing an anti-satellite weapon system.

The system development program, to be conducted from Johnston Island in the Pacific, is designed to demonstrate the feasibility of a non-nuclear anti-satellite weapon. *Thors* and *Thrust-Augmented Thors* will be used to boost the maneuvering final stage—a modified *Agena D*—to satellite altitudes.

No approval for deployment of the anti-satellite weapon has been made. Rather, the program is being conducted as "insurance" against a future need. Although both the Soviet Union and the U.S. have endorsed the United Nations resolution banning bombs-in-orbit, the Dept. of Defense is not taking Soviet declarations at face value. Since the U.S. is not developing the high-yield orbital weapon, the anti-satellite weapon is being developed to counter this or any other Russian space threat.

A go-ahead on the project was given last fall by the Administration after an Advanced Research Projects Agency (ARPA) study had shown that the system was feasible. Management of the program has been given to the Air Force Space Systems Division.

First flight tests of the satellite interceptor could take place as early as late 1965 or early 1966.

An indication of DOD sensitivity to the anti-satellite program is the fact that it is being conducted in absolute secrecy—using the nuclear test ban as a cover. Under the third of the four safeguards promised Congress during the treaty debate—maintenance of a standby atmospheric test capability—DOD has been constructing launch pads and guidance facilities at Johnston Island.

The reason for this secrecy, according to a Defense official, is the fear of Soviet reaction to a development of this sort. The U.S. can't afford not to develop this capability, they argue, but, at the same time, Soviet knowledge of the program might jeopardize the easing of U.S./USSR relations.

● **Ground-based interceptor**—The early *Saint* program was oriented around co-orbital inspection of a potential target and neutralization if the vehicle was found to be hostile. However, this approach is now considered too expensive and payload-limited and has been re-oriented around the use of a manned spacecraft such as *Gemini*.

Concurrently, the accuracy of space boosters has increased and important new capabilities are being added to ground-based detection, tracking and identification systems.

In addition to the present Space Tracking and Detection System (SPADATS) radio, radar and optical networks, three significant improvements which make a ground-based anti-satellite system feasible are the huge phased-array radar at Eglin AFB, Fla., the Haystack antenna at Tyngsboro, Mass., and the Passive Optical Surveillance System at Cloudcroft, N.M. The Air Force has also asked Congress for money in the Fiscal Year 1965 budget for a precision three-site radar to determine satellite orbits within a few feet by triangulation. This capability is directly related to an antisatellite program.

With ground-based techniques being perfected, Defense officials feel that the need for a co-orbital identification system is lessened. Therefore, the anti-satellite system will work on the principle of boosting a defensive payload with limited maneuverability into the carefully predicted path of a target satellite. Ground commands can be used to correct the trajectory of the vehicle, with final homing accomplished by radar.

Among the non-nuclear kill mechanisms which can be used are steel pellets sprayed out in a counter-trajectory to that of the target, high explosives, or passive means—such as changing the thermal control of the satellite so that it overheats or damaging solar cells so that power supplies are degraded.

Dr. Harold Brown, Director of Defense Research and Engineering, has endorsed the ground-based anti-satellite weapon, saying that "for a given booster, surface-launched vehicles will have greater accuracy and will have more payload than if you start from space and are aiming at another satellite."

Although Brown told his audience last October that he was not "trying to discredit the entire hunter-killer approach" to satellite interception, he was trying to point out that "the best way to go about it would be from the ground or the sea, not from space, insofar as achieving a particular end for a given investment."

Special target vehicles launched from the Eastern Test Range (Cape Kennedy) at varying inclinations would give SPADATS the maximum opportunity to detect, track and identify the target and predict orbital parameters before the anti-satellite missile was sent aloft. One expert told MISSILES AND ROCKETS that non-cooperative satellites could be detected and their orbital ele-

Making

by James Trainor

ments predicted to within 50-100 ft. after the first several passes, with refinement to any desired degree within a couple of days.

A program of increasing difficulty could complicate the tracking task through in-orbit maneuvering of the target or absorbent radar coatings to reduce the cross-section of the target. Primary interest in the anti-satellite program would be satellites in low-Earth orbits (100 to 400 n. mi.).

• **Funding**—As with most defense programs, the anti-satellite weapons system is designed to get the maximum return on investment. The boosters will be *Thors* converted from the stockpile of weapons being reconditioned at Douglas Aircraft Co.'s Tulsa Division. The boosters for the targets are likely to come from the same source. Systems for the maneuvering intercept stage are being solicited from industry under classified RFP's.

Construction on Johnston Island has absorbed the major share of the funds so far. ARPA and the Air Force reprogrammed $16.5 million to the project and Congress appropriated $20 million more in FY '64.

In addition to this $36.5 million, $4 million is included in the FY '65 budget to complete construction. Under the safeguards program $77 million more is tagged for Johnston Island. Construction is being handled by the Navy's Bureau of Yards and Docks and is aimed at completion by June of this year.

The island is being enlarged by 270 acres and two new islands of 25 acres each are being created to accommodate additional communications and guidance facilities. On the main island, the runway is being extended, two *Thor* pads are being built with blockhouses and living quarters, and docks and other support facilities are being added. Long-leadtime instrumentation, instrument carriers and *Thor* boosters are being funded under the $77-million allocation.

The Air Force budget carries another $98 million for a classified project which may or may not be the anti-satellite program.

Personnel on Johnston Island exceeds the number present at the peak of the Dominic series of nuclear tests. During February there were 1,930 people on the island—Joint Task Force 8 accounted for 405 military and 425 civilians, and the Air Force totalled 275 military and 825 civilians.

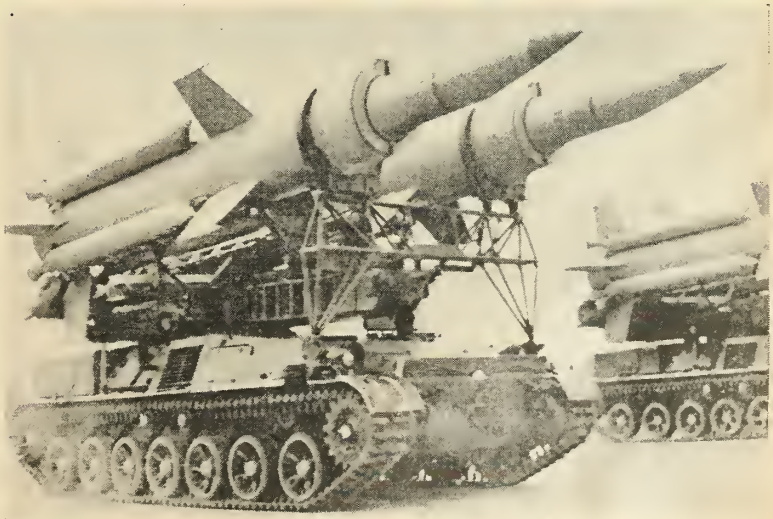
• **Previous anti-satellite programs**—The present anti-satellite program most closely resembles the Navy's *Early Spring* proposal in 1960. This was a minimum-energy missile launched vertically with just enough power to arrive at the satellite orbit. There it could hover, the Navy contended, for as long as 90 seconds until the satellite came into sight. Then with terminal guidance it would home on and kill the vehicle.

This approach, the Navy said—and it now appears DDR&E agrees—"could be done very simply, very straightforward. We believe that within a year and a half, for example, we could destroy one of our own satellites as a demonstration of this capability." Such an anti-satellite weapon, according to the Navy, would be one-tenth to one-sixteenth the size of the complex *Saint* approach.

DDR&E adopted this approach three years later in the present anti-satellite demonstration program. Contenders for the mission, before it was assigned to the Air Force, were the Army's *Nike-Zeus* and a sea-based system derived from *Polaris*. *Zeus* could have handled the program but adding another mission to the anti-ballistic missile program was not considered prudent—particularly when *Nike-X* was just being started. Use of *Polaris* would have been expensive and not the easiest way of demonstrating the feasibility of the concept.

In addition to *Saint* and *Early Spring*, the U.S. has had two previous programs in the anti-satellite category. The first was a single-shot attempt, as part of the *Bold Orion* program, to demonstrate the feasibility of an air-launched system. A B-47 launched the solid, two-stage missile 146 miles into space on Oct. 13, 1959. Reportedly, the missile came within four miles of *Explorer VI* as it passed over Cape Canaveral.

The second program was the Navy's *Hi-Hoe*. This also was an air-launched missile whose primary purpose was to demonstrate the feasibility of launching satellites and space probes vertically from a high-flying aircraft—in this case, a Phantom F-4A. A secondary objective was the use of the air-platform for anti-satellite weapons. Tests of the two-stage *Caleb* rocket were conducted at the Pacific Missile Range in 1962. In one test, on July 25, the 150-lb. payload reached an altitude of 1,000 mi. ■



Reds Parade 'New' Twin Rockets

SOVIET UNION chose traditional May Day parade in Red Square to display these twin vehicle-mounted rockets, which it called "a new formidable weapon." Western observers believed they were late versions of ground-to-air missiles.

AF, NASA in Tentative Agreement on Launch Vehicle Family

by Hal Taylor

AIR FORCE AND NASA space science officials have reached a preliminary agreement on a standardized family of launch vehicles for unmanned missions in the 1970's.

It will be composed of *Scout, Thor, Titan II* and *Titan III* boosters, says Dr. Richard Morrison, director of launch vehicles in NASA's Office of Space Sciences and Applications.

"The Air Force has told us that this is what they want and we agree with them," Morrison said.

He pointed out, however, that the proposed boosters have not been approved by top NASA or Defense Dept. officials.

● **Missing**—As presently planned, the list does not include such vehicles as the *Atlas, Centaur* or *Agena*. Instead, the plans call for the development of two new stages that would be used as upper stages on *Titan II* and *Titan III*.

One would be a 40,000-lb-thrust high-energy stage—on which the Air Force is expected to do preliminary design work in Fiscal Year 1965—and a 7,000-lb.-thrust kick stage for lunar and planetary missions.

Dr. Morrison also said that:

—NASA has asked eight firms to submit bids by May 19 on a program-definition of a 7,000-lb. liquid hydrogen/fluorine kick stage. It is not yet certain whether funds for hardware development will be included in the FY '66 budget.

—A decision will be made in two weeks on details of the NASA program to uprate the *Atlas* by the addition of fluorine to its oxidizer.

—Consideration is being given to the use of the *Titan III* core—minus the strap-on 120-in. solid motor and the transtage—as the launch vehicle for heavy *Surveyor* spacecraft flights in 1967.

● **Panel study proceeding**—Discussion of the U.S. booster stable for the next decade has been going on in the launch vehicle panel of the Aeronautics and Astronautics Coordinating Board. A decision may be reached by fall. The *Atlas* booster would be dropped from the list primarily because it is being phased out as an intercontinental ballistic missile and neither NASA nor the Air Force wants to maintain its production line simply for use in the space program.

One vehicle conspicuously absent from the list is the *Saturn IB*, now under development by Marshall Space Flight Center. It is pointed out that the *Titan III*—even without the addition of a new upper stage—has an escape payload of about 5,100 lbs.

The *Saturn IB*—in its two-stage configuration—has no escape payload capability. While the addition of a third stage would give it an escape payload approximately the same as the *Titan III*, officials believe it would be much more expensive than the Air Force booster.

The *IB*, however, is expected to be used as the booster for the *Voyager* test flight in 1969 and the *Voyager* mission in 1971. It would also come under the current thinking as the booster for man-rated missions as well as carrying supplies to the lunar surface.

● **Uprating Atlas**—The Floxed *Atlas* program is expected to boost the vehicle's payload capability by 30%. Estimates of its cost vary from about $30 million to $45 million.

The two firms that will receive most of the funds are Rocketdyne, prime contractor for the vehicle's liquid engines, and General Dynamics/Astronautics, *Atlas* prime contractor.

Plans now call for an engine test program, parts qualification and tankage tests.

The engines and components will be assembled into a vehicle and the first flight test is scheduled for the second quarter of 1966.

While the ground-test portion of the program is relatively firm, officials are still undecided on the flight-test phase.

They are currently weighing the use of two *Atlas D* boosters—left over from Project *Mercury*—as the flight-test vehicles against a counter proposal by the Lewis Research Center. Scientists from that field installation want the space agency to buy two new *Atlas-Agena* combinations to be used in the flight-test program with a payload launched into space on the first flight. A decision is expected in about two weeks.

Purchasing two new *Atlas-Agena's* would push the total cost of the program from $30 million to $45 million. ■

Five Bid on Titan III Propulsion

FIVE FIRMS have submitted bids for a contract to develop an alternate propulsion system for the *Titan III* transtage.

The firms are TRW Space Technology Laboratories, Rocketdyne Div. of North American Aviation, Inc., United Technology Center, Reaction Motor Div. of Thiokol Chemical Corp., and Bell Aerosystems Co.

The request for proposals was issued early in April, and the firms responded late last month. The contract is expected to be awarded in the near future.

The action was taken after problems with the transtage propulsion system threatened to cut the payload capability of the big booster, designed to launch the Air Force *Manned Orbiting Laboratory (MOL)*.

While the design specifications originally called for the *Titan III* to be able to boost a 5,100-lb. payload to escape velocity, informed sources report that the problems with the transtage propulsion system had reduced this to 4,200 lbs.

Aerojet-General, prime contractor for the stage's current propulsion system, is attempting to solve the technical problems affecting it. The sources said the engines are not producing the specific impulse called for in the specifications.

The transtage is designed to develop 16,000 lbs. of thrust from its twin thrust chambers. The single engine powering the stage also has a restart capability.

It has been nicknamed the "switch" engine because it will be used to change the orbits of *Titan III* payloads. It could also be used to permit a payload to hover in a 22,300-mi.-high synchronous orbit.

Management Breakdown Probably Responsible for Ranger Problems

POOR MANAGEMENT is expected to be cast as the villain in the report on the *Ranger* probe, which has now been almost completed.

In spite of a great many questions on technical aspects of the ill-starred lunar spacecraft program, it appears that the NASA Legislative Oversight Subcommittee of the House Space Committee, chaired in this investigation by Rep. Joseph Karth (D-Minn.), will confine itself to commenting on management policies.

Karth concluded the week-long hearings (M/R May 4, p. 14) with the remark that testimony "indicated to me that there was a serious loss of NASA liaison or NASA management. This, I think, is primarily the question that is before the subcommittee, having arrived at the conclusion . . . that the professional, technical people at Cal Tech are extremely able people. . . ."

House Space Committee Chairman George P. Miller (D-Calif.), indicated his feelings early in the hearings when he told Karth "I hope you have allayed any fears of the Jet Propulsion Laboratory people that we are being critical of them. We are not being critical of anyone. We are trying to explore problems around *Ranger* so that we can answer the critics of NASA and the program that will be sure to arise if we have another not entirely successful flight."

NASA Administrator James E. Webb told the committee at the windup of the hearings that "I feel the committee has a right to feel critical of both NASA and JPL for not solving its management problem. On the other hand, I say we are dealing with a very large program and these problems are not unique. . . ."

● **Some discord remains**—Testimony disclosed that NASA and JPL still do not see eye-to-eye on some matters. Webb said "We haven't yet together found a means to get supervision done in a manner completely satisfactory to both them and to us. I think that is perhaps the fairest statement I could make."

Webb indicated, however, that the agency will take a firm line. The administrator disclosed that JPL will go through an apparent period of trial before the new contract goes into effect January, 1965. During this period, JPL will be asked to carry out some of the new management policies which are permissible but not spelled out in the current contract. This, Webb implied, will prove to NASA that JPL understands what will be expected of it and give it a chance to see if these new policies do indeed remedy the situation before NASA becomes committed to the new contract.

The NASA administrator also made the point that "We have made it clear that *Ranger VII* will not fly until Dr. Seamans and the top group have approved not only what Dr. (Homer) Newell wants to do, but what JPL wants to do. We are going to look at the testing procedure in the light of the best we know in NASA." *Ranger VII* is scheduled for late June, with *Ranger VIII* following in about six months.

● **Why problems existed**—JPL apparently will take the blame for not "projectizing" its management earlier. Dr. Homer Newell, chief of space sciences and applications, made this recommendation two years ago, witnesses said.

"JPL apparently thought they could do the job in an organization that would preserve the values that were important to them and to the university—California Institute of Technology—and still get the job done. . . . Our own experience showed us that it would be almost impossible or certainly extremely difficult for them to accomplish what they were setting out to do, but there was no way for us to be absolutely sure they couldn't do it," Webb said.

He acknowledged later, however, that he "wasn't absolutely sure that NASA could have produced a better situation by being absolutely insistent on having things operated its way."

Like other JPL and NASA witnesses, Webb denied that scheduling had anything to do with *Ranger's* problems. "My view is that the schedules have been pretty hard-boiled, they have not been unrealistic."

● **Industry view**—Barton Kreuzer, vice president and general manager of the astro-electronics division of Radio Corp. of America, denied that his company had ever made any other serious recommendations for changing the switching system or any other part of the television subsystem.

"At the time of *Ranger VI* I would not, Mr. Chairman, have done anything different than JPL did."

Kreuzer disclosed that RCA has run a number of tests in the laboratory to try to simulate the failure of *Ranger VI*, and did get the kind of arcing which apparently knocked out the switching system by simulating the buildup of a static electrical charge on the outside of the launch vehicle shroud. "This external charge might have arced from the cover of the (*Agena* umbilical) connector to one of the pins in it." But these tests "far from prove" this theory, and the real cause will probably never be known," Kreuzer said.

Richard Horner, technical vice president of Northrop Corp., which assisted in a small way in Block III of *Ranger* and was slated to take over management of the program for Block V, likewise voiced support of JPL. Northrop also denied that it was overruled on any suggestions made to JPL, as was implied by a number of the committee's questions.

Although the committee has reserved the right to ask the witnesses for additional information, the hearings are now concluded. The report is expected within a couple of weeks. ■

Soviet Lunar, Planetary Failures May Total 20

THE SOVIET UNION has failed in 15 to 20 consecutive lunar and planetary mission attempts since *Lunik III* photographed the back side of the Moon in 1959.

Although this fact has been intimated by top Washington officials in recent weeks, it was stated publicly for the first time by Dr. Homer Newell, chief of the Space Sciences and Applications division of NASA. The disclosure was made at hearings held by the House Space Committee's NASA Legislative Oversight Subcommittee, currently investigating the *Ranger* lunar spacecraft program.

Newell made the statement to illustrate the technical difficulties of such programs.

Failure of weld blamed . . .

Titan III Engine Explodes During Static Test Firing

120-in. solid, scheduled to burn for 114 seconds, ruptures after 55 seconds shortly after dedication of $10-million UTC facility

by Robert Lindsey



TITAN III MOTOR case like this one blew up during May 2 test.

EDWARDS AFB, CALIF.—Failure of a casing weld caused a five-segment 120-in. *Titan III* solid motor to blow up after 55 seconds during a test here May 2.

Preliminary indications were that the weld failed due to removal prior to the test of a "boot" in the bottom section of the motor.

The blast caused extensive damage to a new $10-million solid-motor test facility which had been dedicated only three hours earlier.

Shifting further tests scheduled for Edwards to United Technology Center's test stand at Coyote, Calif., is expected to avert any delays in the program, Air Force officers said following the spectacular incident.

It was the first failure in the program after three successful five-segment firings at Coyote. Early estimates indicate rehabilitation of the test stand will take two to three months.

The motor had been scheduled to burn for 114 seconds.

The firing looked normal for 55 seconds. Then flames burst out of the segment nearest the forward end closure. From the 10-in. welding break, four inches above the joint, the flames quickly severed the motor and the uncontrolled burning left the test stand in wreckage. The motor fell from its mount during the peak of the holocaust and slammed down on its side. No one was injured.

A UTC official said the motor had produced 1.1 million pounds of thrust, and chamber pressure was a normal 750 psi up until the rupture.

● **Welding reassessment**—Welding technology has been the principal fabrication problem in the *Titan III* solid motor development program.

UTC President Barnet Adelman said the D6AC steel case which failed in the test had been hydrotested and the weld X-rayed, but the contractor had not detected any flaw.

The Astronuclear Lab of Westinghouse Electric Corp. and Curtiss-Wright Corp. both supply cases for the program, but Adelman declined to identify which firm provided this one.

At a post-firing press conference Adelman said, "This indicates we'll reassess the hydrotest procedures and welding techniques." But he said there was no evidence of a design defect in the motors, two of which will provide first-stage energy for the *Titan IIIC*.

Five-segment firings had been scheduled here at one-month intervals. Most of the scheduled tests will be reprogrammed at Coyote, Col. Harold W. Robbins, director of the USAF large solid rocket motor program, said. "Maybe we'll lose the equivalent of one test," he said.

Brig. Gen. Joseph S. Bleymaier, deputy commander for manned systems of the Air Force Space Systems Division, predicted the program can go ahead "without significant delays." Damage to the test stand included the motor mounts, telemetry inputs, other instrumentation and much of the exterior structure.

At the earlier dedication ceremonies, SSD commanding officer Maj. Gen. Ben I. Funk called the new stand "the most sophisticated and highly instrumented facility in the world." Besides the 95-ft. vertical test stand, the complex includes a horizontal stand. The new facility is operated for the Air Force by UTC.

Both test stands are controlled from a central control center. Also included in the project are solid-rocket storage facilities, administrative and service buildings. The instrumentation system provides 600 channels of instrumentation. It utilizes constant bandwidth frequency modulation techniques. Aerojet-General's Aetron built the complex. ■

Moon Base Cost Set at $2 Billion

Semi-permanent installation would provide 542 man-days on lunar surface, AAS meeting told; NASA officials dubious about STEM

by William Beller

NEW YORK—About $2 billion would be needed to buy a semi-permanent base on the Moon. It would give astronauts 542 man-days on the lunar surface. Cheaper installations could be designed and erected, but they would be much more costly on a man-day comparison.

The least expensive way to buy time on the Moon, for the short run, would be simply to send a sequence of *Apollos* there, each vehicle carrying two astronauts able to dwell two days on the lunar surface. For this mission, the unit cost would be about $65 million per man-day, or a total cost of about $900 million. Total cost is figured as the sum of the operating expenses and all development costs above those needed for the first manned lunar landing.

Other plans could drastically cut the unit cost, but they call for development work and expenses not yet approved as part of the National Space Program.

These cost figures are based on a report given last week at the 10th annual meeting of the American Astronautical Society by Maj. Thomas C. Evans, a technical director in NASA's Office of Manned Space Flight.

Nearly 400 engineers and scientists attended the four-day series of meetings dealing with the technical progress made on lunar flight programs.

● **STEM "marginal"**—To put his cost estimates on an economic basis, Evans calls for maximum use of the investments in *Saturn* and *Apollo*. And to put the costs on an equal basis, he proposes using seven *Saturns* for each of the plans already proposed for extending the range of lunar exploration.

Evans discounts the concept of STEM (Stay-Time Extension Module) which calls for transporting "saddle bags" of supplies attached to the outside of the Lunar Excursion Module (LEM). Calling for a "significant payload margin in *Apollo* at a time when this may be hard to provide," STEM is classed by Evans as a "somewhat marginal improvement upon *Apollo*."

On this score, Dr. George E. Mueller, NASA's associate administrator for Manned Space Flight, agreed with Evans. Mueller told MISSILES AND ROCKETS that "the *Apollo* project is already too far along to seriously consider this (STEM) alternative."

Mueller did emphasize to M/R, as Evans and several other speakers did, the "vast" potential in *Apollo* hardware in addition to its use for the first lunar landing. Pointing out that the *Saturn IB*, for instance, could put 17 tons of payload into orbit with each launch, Mueller said "we are rapidly reaching the point where we are no longer launch-vehicle-limited in what we can do in space."

● **ALSS and LESA**—Mueller said that "within the next two years," a decision would be made regarding post-*Apollo* lunar projects. He spoke particularly of two concepts, ALSS (*Apollo* Logistic Support System) and LESA (Lunar Exploration System for *Apollo*).

For ALSS, two *Apollo* shots are required for each mission—one to transport two astronauts, the other to deliver support equipment and supplies to the lunar surface. For a seven-shot program, in which the initial shot is a surface reconnaissance mission flown with *Apollo*, the ALSS program would furnish 86 man-days on the Moon. Evans estimates that such an *Apollo*-ALSS program would cost about $1.35 billion, which reduces to $15.6 million per man-day.

Evans cautioned his listeners against using these cost figures for purposes other than "a general comparison of (lunar exploration) systems." It was generally conceded by other experts, though, that the order of magnitude of the cost figures is also correct.

For LESA, three *Saturn V* shots probably would be required for each mission—one to deliver material on a direct flight to the lunar surface, one to transport three astronauts to the Moon and one to pick up the astronauts 90 days later and return them to Earth. For Evans' seven-shot program, *Apollo*-LESA would yield 542 man-days on the Moon for a total cost of about $2 billion, or less than $4 million per man-day.

Which lunar exploration system will be used depends on how extensively the Moon is to be explored. In turn, this will depend on the specific scientific tasks to be accomplished, funding limitations and—perhaps of equal importance—what Russia does.

● **Apollo, LEM progress**—In a paper on the status of the *Apollo* Command and Service Modules, N. J. Ryker reported that since November, 1963, major accomplishments include the "completion of 12 major CSM test vehicles, the structural completion of the first spacecraft modules, successful results in each of the first test vehicle flights and completion of development tests for most systems."

Ryker is director of vehicle systems, *Apollo*, Space and Information Systems Div., North American Aviation, Inc. He said that during the next year, "several of the major sub-programs will be concluded, most systems will complete qualification testing and the first spacecraft will be in test."

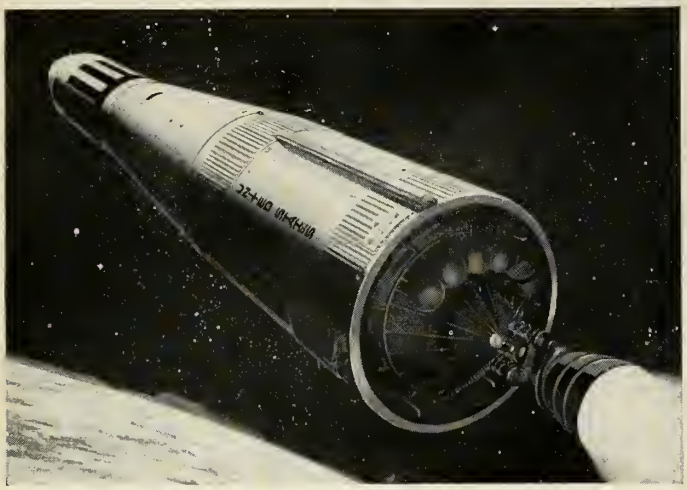
Ryker was particularly enthusiastic about the "heartening" progress on two major CSM programs—the Avco ablative heat shield and the Pratt & Whitney fuel cell.

In a LEM progress report, T. J. Kelly, LEM project engineer, Grumman Aircraft Engineering Corp., said that the technical development of the spacecraft has "progressed into the detailed design stage." Later, Mueller told M/R that this was essentially true for 85% of LEM, but that "15% of the LEM vehicle still has to be design-frozen."

Getting down to particulars, Kelly said the LEM "structure and the electronic subsystems are undergoing early development tests, and the electronic subsystems are largely in detailed design." He asserted that the establishment of mission requirements, control weights and the delta-V budget "has placed the LEM design on a firm footing."

All equipment of LEM engine subcontractors has undergone full-scale, full-duration firings at sea level. "Other subsystems are entering the engineering model or breadboard test phase, with the electronic subsystems the least advanced at this date," said Kelly. ■

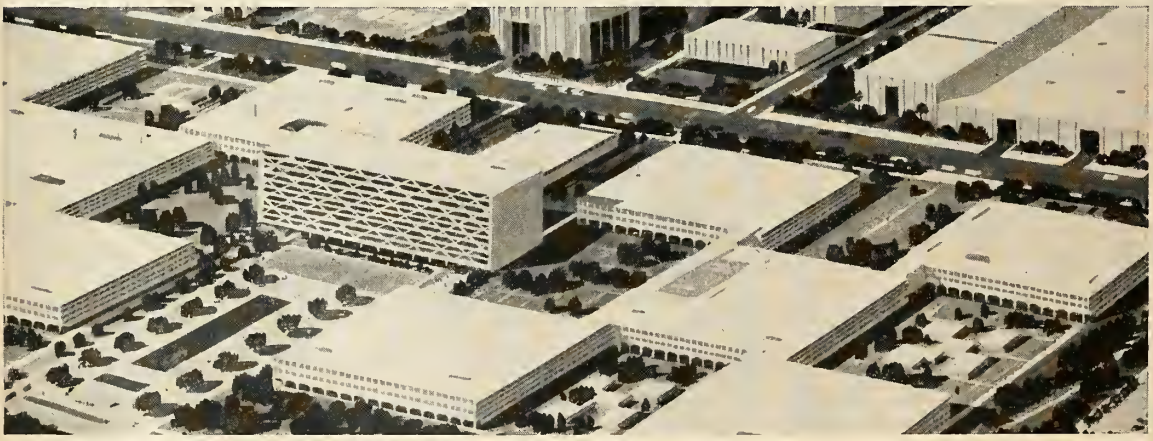
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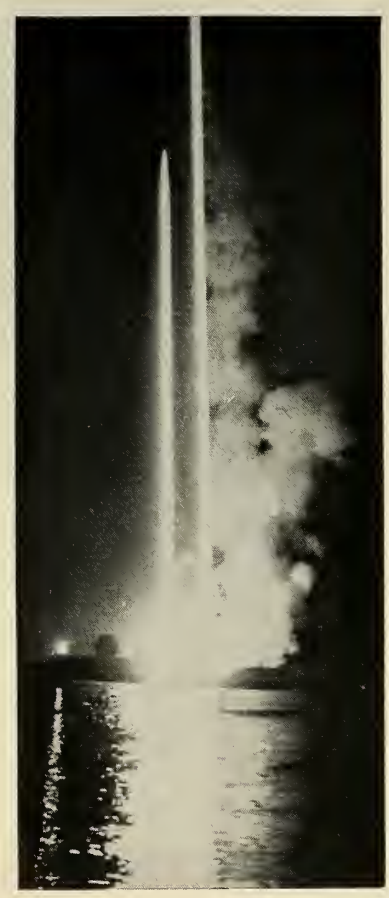


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Missiles and Rockets/May, 1964

ASTROLOG

Current status of U. S. missile and space programs

PHOTO: Two-missile salvo of Nike-Zeus antimissile missiles in Kwajalein Island night firing.



Satellites and Spacecraft

ADVANCED ORBITING SOLAR OBSERVATORY (NASA)—CONTRACTORS: Republic, prime; DESCRIPTION: 1,450 lb. spacecraft to make detailed measurements of Sun's solar radiation; launch vehicle, THRUST AUGMENTED DELTA. STATUS: Two spacecraft will be launched in 196B.

ADVANCED TECHNOLOGICAL SATELLITE (NASA)—CONTRACTORS: Hughes, prime. DESCRIPTION: Five-satellite program to test communication and meteorological equipment at medium and synchronous orbit; weight, 650 lbs.; launch vehicle, ATLAS-AGENA. STATUS: New program in the FY '65 budget; flights scheduled for 1966-68.

★**ANNA** (NASA)—CONTRACTORS: Applied Physics Lab, prime; AF Combridge Research Laboratories/Edgerton, Germeshausen & Grier, flashtube experiments; Army Engineers/ITT, SECOR; transponder developed by Cubic Corp. DESCRIPTION: Geodetic satellite; 600-mi. orbit; 36-in. aluminum sphere (with solar cell belt, 48 in.); weight 355 lbs.; boosted by DELTA or THOR-ABLESTAR; SECOR, 9 x 11 x 14 in.; wt. 40 lbs.; can be carried piggyback on variety of boosters. STATUS: Development; first launch by Navy failed May 10, 1963; second launch successful in November; program now under NASA management; new contractors to be named in a few months; NASA to launch one satellite per year beginning in 1964; SECOR successfully orbited in January by DOD.

★**APOLLO** (NASA)—CONTRACTORS: North American, command & mission modules, systems integration; Grumman, Lunar Excursion Module (LEM); MIT, guidance development; Collins Radio, telecommunications; Honeywell, stabilization & control; AiResearch, environmental control; Northrop-Ventura, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction contals; IBM, realtime camputer complex; Westinghouse, power conversion equipment. Lunar Excursion Module, prime, Grumman; descent engine, Rocketdyne & TRW Space Technology Laboratories; ascent engine, Bell Aerosystems; environmental control, Hamilton Standard; reaction control thruster, Marquardt; guidance, MIT; radar & communications instruments, RCA; TMC, telemetry, Radiation Inc; fuel cell, Pratt & Whitney; external visual display, Farand Optical; DESCRIPTION: Three-man spacecraft for Earth-orbital, lunar-orbital and lunar-landing missions. Boosters: SATURN I and SATURN IB for Earth orbits; SATURN V for lunar rendezvous; 3-module spacecraft: Command Module weight, five tons; Service Module, 23 tons, Lunar Excursion Module, 12.75 tons; total weight, 85,000 lbs. STATUS: Unmanned Earth orbital shots scheduled 1964-67; lunar orbits 1968; lunar landing by 1970; first manned orbital flight first half 1967.

★**ASSET** (Air Force)—CONTRACTORS: McDannell Aircraft Corp., prime; Honeywell, guidance. DESCRIPTION: Aerothermodynamic/elastic Structural Systems Environmental Tests for various materials combinations during re-entry; delta-shaped re-entry vehicle; two versions planned weighing 1,100 lbs. (4 vehicles) and 1,200 lbs. (2); Length, 68.7 in.; span, 58.9 in. STATUS: Development; program to be expanded to study different shapes, materials, etc. One AMR shot in September, 1963, successful although vehicle not recovered; revised and expanded program being planned, as a consequence of DYNA-SOAR cancellation; to provide more information on lifting body re-entry.

BIOS (NASA)—CONTRACTORS: GE, prime. DESCRIPTION: 1,000-1,300 lb. recoverable capsules with primates aboard; capable of orbital flights up to 30 days; launch vehicle, DELTA and THRUST-AUGMENTED DELTA. STATUS: Six flight models to be built; first flight in December, 1965; others to follow at three-month intervals; first experiments selected in February.

COMSAT CORP. SATELLITE PROGRAM—CONTRACTORS: Proposals submitted by Hughes, Philco, TRW with ITT, and AT&T and RCA as joint contractors. DESCRIPTION: Experimental synchronous satellite to be launched in 1965. STATUS: six-month contracts to be let for design and engineering on system; initial operational capability expected in 1966.

DISCOVERER (Air Force)—CONTRACTORS: Lockheed, prime; GE, re-entry vehicle. DESCRIPTION: THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems. STATUS: Program life extended; all data on launchings classified as part of DOD information policy; testing of AGENA D assigned to DISCOVERER program.

ECHO (NASA)—CONTRACTORS: Langley Research Center, prime. DESCRIPTION: ECHO I, 135-ft. inflatable sphere in 700- to 805-mi. orbit; passive communication satellite; THOR for ballistic tests; THOR-AGENA for orbital. STATUS: ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful. ECHO II launched from Vandenberg Jan. 27; U.S.-USSR conducting series of cooperative experiments using ECHO.

★**GEMINI** (NASA)—CONTRACTORS: McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM guidance system integration and computer; Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment. DESCRIPTION: Bigger and heavier MERCURY-type capsule to carry two men for up to two weeks; TITAN II to be used as booster; ATLAS-launched AGENA will be used for rendezvous missions; 15 spacecraft will be produced. STATUS: Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, April, 1964, successful; manned and rendezvous flights, 1965-67; AF participating in program, and will modify Gemini Capsules for MANNED ORBITING LABORATORY.

★**HYPERSONIC RESEARCH VEHICLE** (AF, NASA)—CONTRACTORS: None announced. DESCRIPTION: Manned, hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, Mach 0-3; ramjet, Mach 3-8 or 10 (oxygen collected and liquefied during this cycle); Mach 8-10 orbital speeds, LH_2-LOX rocket. STATUS: Joint NASA-AF research program approved; NASA funding $2.5 million in FY '65.

INTERPLANETARY MONITORING PLATFORM (NASA)—CONTRACTORS: Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit. DESCRIPTION: 125-lb. satellite launched into deep-space orbit with an apogee of 172,000 mi.; will measure radiation and solar flare hazards in advance of Project APOLLO; launched by DELTA booster from AMR. STATUS: Program calls for eight satellites; launches will begin in second half of 1964; later flights will use a nuclear power unit as replacement for solar cells.

ISIS (Canada, U.S.)—CONTRACTORS: Canadian Defense Research Board, satellite; NASA, launch vehicle. DESCRIPTION: Three-satellite follow-on program to ALOUETTE to continue ionospheric studies. STATUS: Design of ISIS A to begin this year with launch in 1967; B and C to be launched in 1968, 1969.

LUNAR LOGISTICS VEHICLE (NASA)—CONTRACTORS: None. DESCRIPTION: Spacecraft to carry support payloads to the Moon. Two designs under study—LEM Truck and logistics spacecraft with 25,000 to 30,000 lb. payload. STATUS: Program decision expected 1964; no funding expected until FY '66; program would cost about $1 billion.

LUNAR ORBITER PHOTO CRAFT (NASA)—CONTRACTORS: Boeing, prime; RCA, power and communications; Eastman Kodak, cameras. DESCRIPTION: 800-lb. spacecraft launched by ATLAS-AGENA will orbit Moon taking pictures of lunar surface; radioactive and geodetic measurements will also be taken. STATUS: Ten flights scheduled beginning in 1966.

★**MANNED ORBITING LABORATORY** (Air Force)—CONTRACTORS: Study contracts awarded to Douglas, GE, and Martin on the ORBITING SPACE STATION (OSS). DESCRIPTION: Two-man spacecraft to establish military usefulness of man in space; booster, TITAN III; GEMINI-X capsule atop 10 ft.-dia, 20-ft. long canister lab; total weight about 18,000 lbs.; orbit below 350 mi.; flights of 30 days in shirt-sleeve environment planned. STATUS: Pre-program definition; unmanned GEMINI launch early 1966; unmanned canister launch late 1967, manned first half 196B; rendezvous capability possible later.

MARINER (NASA)—CONTRACTORS: Jet Propulsion Laboratory, prime. DESCRIPTION: 550-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1,000-lb. MARINER B also under development. STATUS: Twelve shots planned; first scheduled Venus fly-by, August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus, Dec. 14; two Mars fly-by missions planned in late 1964 and one in 1966.

★**MDS** (NASA)—CONTRACTORS: Fairchild Stratos, prime. DESCRIPTION: 3,400-lb. meteoroid-detection satellite employing two 50 x 15-ft. extend-

★ Indicates changes since March 1964 Astrolog

able detector wings; Earth orbit 300 to 800 mi.; booster, SATURN I. STATUS: Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch scheduled for third quarter 1964; three will be orbited.

MIDAS, PROGRAM 239A (Air Force)—CONTRACTORS: Lockheed, prime; Aerojet, IR detector system. DESCRIPTION: Early-warning satellite; detect ICBM launchings by IR; two flights conducted in 1963 detected solid and liquid missile launches. STATUS: Development; no decision on deployment; reportedly competing with over-the-horizon radar.

★MILITARY COMMUNICATIONS SATELLITE (Program 369) (AF, DCA, Army)—CONTRACTORS: Philco-TRW/STL have completed studies. DESCRIPTION: Multiple-launch, random, active repeater comsat; total of 60 satellites launched in series of 6-8 satellites in 6,000 n.mi. polar orbits placed in planes 45° apart; weight, about 100 lbs.; ATLAS-AGENA booster. STATUS: DOD maintaining contractors at sustaining level; program definition completed; decision on development delayed until DOD determines suitability of Comsat Corp. system; synchronous system shelved.

★NATIONAL ORBITING SPACE STATION (NASA, AF)—CONTRACTORS: Many studies awarded. DESCRIPTION: Manned space station with orbital lifetime of one to five years for testing components and techniques in the space environment; weight ranges under study vary from 15,000-20,000 up to 200,000 lbs. STATUS: Decision not expected for one to four years; EXTENDED APOLLO, AF MANNED ORBITING LABORATORY, MANNED ORBITING RESEARCH LABORATORY and LARGE ORBITING RESEARCH LABORATORY being considered.

NIMBUS (NASA)—CONTRACTORS: Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras. DESCRIPTION: 750-lb. second-generation weather satellite; Earth-stabilized polar orbiting; TV cameras and IR scanners in payload; THOR-AGENA B booster. STATUS: First launching scheduled for July; second, six months later; two R&D satellites to be funded in FY '65; uses Automatic Picture Transmission system.

OAO (NASA)—CONTRACTORS: Grumman, prime; Westinghouse, ground station, components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage; Hughes and Avco, communications equipment. DESCRIPTION: 3,500-lb. orbiting astronomical satellite to study ultraviolet spectrum from approximately 1,200 Å to 4,000 Å; four major experiments selected; one piggyback; booster, ATLAS-AGENA D. STATUS: Three flights beginning in late 1965; three more spacecraft to be contracted for this year.

★OGO (NASA)—CONTRACTORS: TRW Space Technology Laboratories, prime; DESCRIPTION: 1,000-lb. satellite with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA D, ATLAS-CENTAUR boosters. STATUS: First flight scheduled in July, 1964; 10 experiments planned for first shot; five other flights planned.

OSO (NASA)—CONTRACTORS: Ball Brothers, prime; DESCRIPTION: OSO I, 458-lb. orbiting solar observatory; OSO II, 535-lbs.; DELTA and ATLAS-AGENA boosters; S-16 early version; S-17 and S-57 advanced versions. STATUS: First flight Mar. 7, 1962, highly successful; first flight for S-17 planned for second quarter 1964 delayed six months to a year; five more flights planned.

★PIONEER (NASA)—CONTRACTORS: TRW Space Technology Laboratories. DESCRIPTION: 136-lb. spin-stabilized solar probe; augmented DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; four outrigger booms for stabilization; five experiments, 60 to 90-million-mi. communication capability. STATUS: Seven launches in program; early 1965 launch schedule set; orbits range from 0.8 to 1.2 au for 6-mo. lifetime; ADVANCED PIONEER under study.

★RANGER (NASA)—CONTRACTORS: JPL, prime; Aeronutronic, capsule; Hercules, retro-rocket; Northrop, support contractor; RCA, TV system. DESCRIPTION: 300-lb. instrument capsule with seismometer for rough landing on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster. STATUS: RANGER VI launch Jan. 30; TV system failed; five-man panel reviewing program; total of nine spacecraft planned. RANGER VII scheduled for June.

RELAY (NASA)—CONTRACTORS: TRW Space Technology Laboratories, project coordination and systems planning; RCA, prime. DESCRIPTION: 172-lb. spin-stabilized wideband 700 to 4,000-mi.-orbit active repeater experimental communications satellite. DELTA booster. STATUS: Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; RELAY II launched Jan. 21, 1964.

SAMOS (Air Force)—CONTRACTORS: Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco and Northrop Ventura. DESCRIPTION: Reconnaissance satellite; formerly SENTRY; R&D model weighs 4,100 lbs. with E-5 capsule (3,000 lbs. with E-6); ATLAS-AGENA booster; 100-300-mi. circular polar orbit. STATUS: Operational; advanced SAMOS under development; FERRET version used for electronic intelligence and communications eavesdropping.

★SATELLITE INSPECTOR (Air Force PROGRAM 706)—CONTRACTORS: RCA, prime; Hughes, detection equipment. DESCRIPTION: Satellite inspection system consisting of a spacecraft capable of co-orbital inspection of non-cooperative satellites. STATUS: Re-oriented from unmanned vehicle to manned satellite using GEMINI; Conceptual preliminary design studies under way; early GEMINI flights expected to provide important inputs; $2 million in FY '65 budget.

SERT (NASA)—CONTRACTORS: RCA, prime. DESCRIPTION: Spinning satellite carrying two electric-propulsion engines for environmental tests. STATUS: Two, and possibly three flights planned first, third quarter, 1964.

SURVEYOR (NASA)—CONTRACTORS: Hughes, prime; Martin, SNAP device. DESCRIPTION: 2,100-lb. spacecraft for soft-landing 100-300 lbs. of instruments on Moon; ATLAS-CENTAUR booster; SNAP nuclear generator optional. STATUS: First Moon flights early 1965; seven soft-landing vehicles planned.

SYNCOM (NASA)—CONTRACTORS: Hughes, prime. DESCRIPTION: 24-hr. orbit instantaneous narrow band, active repeater communications satellite; 28-in. dia. and will weigh about 55 lbs.; DELTA booster; capable of accommodating one full duplex radio telephone channel. STATUS: First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost; SYNCOM II launched July 26, 1963, completely successful; another launch scheduled for mid 1964; 500-lb. ADVANCED SYNCOM cancelled.

SMS (Synchronous Meteorological Satellite) (NASA)—CONTRACTORS: Republic, RCA Astro-Electronics; Hughes, study contracts. DESCRIPTION: 24-hr. weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or -CENTAUR. STATUS: Studies to continue; development funds not included in FY '65 budget.

TELSTAR (AT&T, NASA)—CONTRACTORS: Bell Telephone Laboratories, management for AT&T. DESCRIPTION: 170-lb. active repeater experimental industry communication satellite; DELTA booster. STATUS: Development; first launch July 10, 1962, highly successful; second launch May 7, 1963, also successful.

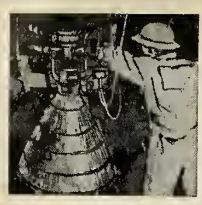
TIROS (NASA, Weather Bureau)—CONTRACTORS: RCA, prime. DESCRIPTION: 285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (300-3,000 mi.). STATUS: R&D; eight satellites launched; all successful; next launch, summer 1964; seven more added to program (four R&D, NASA; three operational, Weather Bureau).

★TRANSIT (Navy)—CONTRACTORS: Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers. DESCRIPTION: Navigational satellite; R&D model over 250 lbs.; operational, 50 to 100 lbs.; operational system; four satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; ABLESTAR booster. STATUS: Operational system in process of being established for use by POLARIS subs; two nuclear-powered (SNAP-9A) satellites launched in 1963.

VELA HOTEL (ARPA)—CONTRACTORS: TRW Space Technology Laboratories, prime; Los Alamos Scientific Lab/Aerospace Corp., payload. DESCRIPTION: 20-sided, 485-lb. satellite for detection of nuclear explosions in space; 50,000-mi. orbit; booster, ATLAS-AGENA; launched in pairs. STATUS: First pair successfully launched in October, 1963; remaining four pairs being modified to avoid duplicating data.

VOYAGER (NASA)—CONTRACTORS: Study contracts, Avco and GE. DESCRIPTION: Unmanned MARINER follow-on spacecraft to orbit Mars and VENUS and to eject a capsule to the surface. STATUS: Development funds not included in FY '65 budget; launches in 1968-70 period; spacecraft of 6,000 lbs. to be launched by three-stage SATURN IB or SATURN V.

X-15 (NASA, AF, NAVY)—CONTRACTORS: North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Honeywell, adaptive flight control electronics. DESCRIPTION: Manned rocket plane capable of 4,000-mph-plus flight at edge of space; single rocket engine develops 57,000 lbs. thrust. STATUS: Powered flights in progress; unofficial records set—altitude 354,200 ft. and speed 4,104 mph; hypersonic propulsion research program should run through 1968; more than 100 flights have been made; ramjet (X-15A2) program approval expected soon.



Space Vehicles

★**ABLESTAR** (Air Force)—CONTRACTORS: Spoce Generol, prime; Aerojet, propulsion; Spoce Generol/Bell Telephone, guidonce. DESCRIPTION: 2,000-lb. upper stage; 9.5 ft. long; 55 in. dio.; rodio commond guidance; propellonts, UDMH/IRFNA; restort copobility; STATUS: Used in TRANSIT, ANNA ond other militory programs; THOR booster.

★**AGENA D** (Air Force)—CONTRACTORS: Lockheed, prime; Honeywell, guidonce; Bell, propulsion. DESCRIPTION: 1,700-lb. upper stoge; 25 ft. long; 5 ft. dio. all-inertiol guidonce; propellants, UDMH/IRFNA; mutiple re-start copability; ATLAS, THOR ond THOR augmented boosters. STATUS: Used in DISCOVERER, SAMOS ond other militory progroms os well as o voriety of NASA programs; e.g., MARINER, RANGER, OAO ond OGO.

★**CENTAUR** (NASA)—CONTRACTORS: Lewis, progrom monogement; General Dynamics/Astronoutics, prime; Pratt & Whitney, propulsion; Honeywell, guidonce. DESCRIPTION: High-energy upper stoge using o poir of RL-10 LOX/liquid hydrogen engines; 30,000 lbs. totol thrust; 30 ft. long; 10 ft. dia.; ATLAS D booster; copable of orbiting 8,500 lbs.; 2,300 lbs. to escape; 1,300 lbs. on plonetory flights. STATUS: Development; first test flight foiled; second lounch Nov. 27, 1963, highly successful; third scheduled for June-July, 1964.

★**DELTA** (NASA)—CONTRACTORS: Douglos prime; Bell Telephone Lobs, guidance; Rocketdyne/Aerojet/Allegony Ballistics Loborotory, propulsion. DESCRIPTION: Successor to THOR-ABLE; upper stoge guidonce; three-stage vehicle; 800-lb. poylood copobility in 100-mi. orbit; THRUST-AUGMENTED DELTA poylood copobility 1,500 plus lbs. in 100-mi. orbit; THOR missile comprises first stoge. STATUS: lounch vehicle for TIROS, EXPLORER, OSO, BIOS, ECHO; TAD used for SYNCOM & PIONEER; 26 previously on order ougmented by AF order for 21 more for NASA; THRUST-AUGMENTED DELTA with three solid motor strop-ons olso being used.

★**LITTLE JOE II** (NASA)—CONTRACTORS: Generol Dynomics/Convoir, prime. DESCRIPTION: Solid-propelled vehicle with 800,000-lb. thrust; lounch vehicle for APOLLO suborbitol flights. STATUS: First lounch Aug. 28, 1963, successful; six vehicles ordered thus for. Second lounch scheduled for Moy, 1964.

★**ORION** (Air Force)—CONTRACTORS: Generol Atomic. DESCRIPTION: Spoce booster propelled by series of otomic explosions to lift more thon 1,000 tons into orbit. STATUS: Cancelled by DOD, no military requirement; NASA reportedly interested in concept.

★**POST-SATURN V LAUNCH VEHICLE** (formerly NOVA) (NASA)—CONTRACTORS: Martin, study. DESCRIPTION: Copobility of Novo under study; no firm concept but should offer significont improvement over C-5 (20-30 million lb. first-stoge thrust or nucleor upper stage). STATUS: Study to determine chorocteristics; operational target date post-1970.

ROVER (NASA, AEC)—CONTRACTORS: Los Alomos Scientific Lobs, ROVER prime; Aerojet, NERVA prime; Westinghouse, propulsion. DESCRIPTION: First nucleor rockets; tests of Kiwi, prototype of NERVA engine, under woy. STATUS: Kiwi tests to be completed this yeor; development of Phoebus reactor initiated; no flight test progrom funded ot present.

★**SATURN I** (NASA)—CONTRACTORS: Systems engineering, ossembly ond guidonce, Morsholl Center; S-1 stoge, Chrysler Corp.; S-IV, Douglos. DESCRIPTION: two-stoge vehicle for eorly boilerplote tests of APOLLO; first stoge: eight Rocketdyne H-1 engines; second stoge: six Prott & Whitney RL-10-A3 engines; 22,000 lbs. into 345-mi. orbit. STATUS: Four flight tests of first stoge successful; oll flights with inert upper stoge; first flight with live upper stoge successfully lounched Jan. 27, putting 37,700 lbs. in low Eorth orbit; SA-6 scheduled for Moy, 1964.

SATURN I-B (NASA)—CONTRACTORS: Systems engineering, ossembly ond guidonce, Morsholl Center; S-1 stoge, Chrysler; S-IVB stoge, Douglos. DESCRIPTION: S-1, eight H-1 engines; S-IVB, one J-2 engine; poylood capability, 32,000 lbs. in 345-mi. orbit. STATUS: Development; first flight 1965; boost APOLLO spocecroft boilerplote models, including lunor londing vehicle; odvonced version able to orbit 30 tons under considerotion.

SATURN V (ADVANCED SATURN) (NASA)—CONTRACTORS: Systems engineering, ossembly ond guidonce, Morcholl Center; S-IC, Boeing; S-II. North Americon; S-IVB, Douglos; F-1, North Americon; J-2, North Americon. DESCRIPTION: S-IC, five F-1 engines; S-II, five J-2 engines; S-IVB, J-2 engine; 120-ton poylood in 345-mi. orbit; 43 tons to escope velocity; 30 tons for plonetory missions. STATUS: R&D; first flight scheduled for 1966; prime booster for APOLLO missions; moy olso be used to boost orbiting spoce stotion.

★**SCOUT** (NASA)—CONTRACTORS: LTV Astronoutics, prime; Honeywell, guidonce; Aerojet/Thiokol/Allegony Ballistics Loborotory, propulsion. DESCRIPTION: Solid propulsion four-stage sotellite louncher; 72 ft. long; 3.3 ft. dia.; 300-lb. poylood in 345-mi. orbit; 80 lbs. to escope. STATUS: Operotionol; used by NASA for EXPLORER and other smoll poyloods; olso procured by NASA for Air Force os BLUE SCOUT; NASA hos ordered 23 more boosters.

★**TITAN III** (Air Force Progrom 624A)—CONTRACTORS: Mortin, systems integrotion; United Technology, large solid boosters; Mortin, TITAN II vehicle; Aerojet, liquid engines; Martin, stondordized upper stage; AC Spork Plug, guidonce. DESCRIPTION: Quick-reoction vehicle for millitory space missions; will be used to boost MOL/GEMINI B; Zero stoge, two 120-in. solid motors; first ond second stoges, TITAN II (storoble propellants); third-stage stondordized vehicle to be developed; modified TITAN II guidonce; poylood, 25,000 lbs. in 100 n.mi. orbit, 2,100 to 22,300-mi. orbit; 5,000 to escope. STATUS: Development; first flight lote 1964 (T-IIIA); Jonuory, 1965 (T-IIIC); 17 development flights plonned; five TITAN II core vehicles (A version), 12 full TITAN III's (C version); operotionol in 1965; 120-in. solid fired successfully July 20, 1963; second solid motor exploded during Moy 2 test at Edwords AFB.



Missiles

★**AADS-70** (Army)—CONTRACTORS: Hughes/Douglos/FMC, RCA/Beech, competitive component development contracts. DESCRIPTION: Field ormy bollistic missile defense system, mobile. STATUS: No decision to develop system hos been mode; component development funded ot $5 million in FY '65; expected to provide bosis for progrom definition in 1965.

ALFA (RUR-4) (Novy)—CONTRACTORS: Novy, prime; Avco, frome; Naval Propellant Plont, propulsion. DESCRIPTION: ASW, surfoce-to-underwater; weight, 500 lbs.; solid propulsion; H.E. depth charge; ronge, 900 yds.; guidonce, free-flight. STATUS: Operotionol; deployed on destroyers ond cruisers.

ASROC (RUR-5A) (Novy)—CONTRACTORS: Honeywell, prime; Songomo Electric, sonor; GE, torpedo; Libroscope-Generol Precision, fire control. DESCRIPTION: ASW, surfoce-to-underwoter; weight, 1,000 lbs.; solid propulsion; worheod, nucleor or conventionol; ronge between 1,800 yds. ond 8 mi.; guidonce, unguided. STATUS: Operotionol on DE, DD, DLG,

& heavy cruisers; one "live" weopon fired in Pocific nucleor tests; industry competition for extended ronge version expected this yeor.

ASTOR (Mk-45) (Novy)—CONTRACTORS: Westinghouse, prime. DESCRIPTION: Mork 45 ASW, underwoter-to-underwoter torpedo; weight, over 2,000 lbs.; solid propulsion; 1 worheod, nucleor or conventionol; ronge, obout 11 n.mi.; guidonce, wire. STATUS: In production; to be deployed on hunter-killer submorines.

ATLAS (PGM-15) (Air Force)—CONTRACTORS: TRW Spoce Technology Loborotories, systems engineering & technicol direction; GD/Astronoutics, frome; GE/Burroughs/Arma, guidonce; Rocketdyne, propulsion; GE/Avco, re-entry vehicle. DESCRIPTION: ICBM; weight, 266,000 lbs.; liquid propulsion; warheod, nucleor; range, 5,500-9,000 mi.; ATLAS "E" ond "F" series inertial guidonce, ATLAS "D" radio inertiol. STATUS: 13 squodrons operotionol ot 11 bases; totol number of missiles, 126; phoseout of ATLAS D's to begin in FY '65; ATLAS Stondord Lounch Vehicle being developed for AF spoce progroms; 5-engine model proposed.

BOMARC A (AIM-10A) (Air Force)—CONTRACTORS. Boeing, prime; IBM/Westinghause, guidance; Aerojet/Morquordt, propulsion. DESCRIPTION: Surface-to-oir interceptor; weight, 15,000 lbs.; liquid booster/romjet propulsion; worheod, nucleor; ronge, 200 n.mi.; guidonce, commond vio SAGE; speed, Mach 2.5; ceiling, over 68,000 ft. STATUS: Five boses operationol in northeostern U.S. to be phased out by the end of 1965; production completed; costs $20 million per yeor to operote system.

BOMARC B (AIM-10B) (Air Force)—CONTRACTORS: Boeing, prime; Generol Precision Aerospoce/Westinghouse/IBM, guidonce; Thiokol/Morquardt, propulsion. DESCRIPTION: Surfoce-to-oir; weight, 16,000 lbs.; solid booster/romjet propulsion; warheod, nuclear; ronge, more thon 400 n.mi.; guidonce, commond vio SAGE; speed, Moch 2.7. STATUS: First bose operotionol Moy, 1961; two more plonned; production completed.

★BULLPUP (AGM-12C) (Navy-Air Force)—CONTRACTORS: Mortin, prime; Moxson Electranics Co., guidonce ond control; AMF, liquid engine; Thiokol, solid propulsion; Naval Propellant Plont, solid propulsion (motor loading). DESCRIPTION: Air-to-surface; ronge, 3-6 mi.; guidonce (visuol reference), radio-link commond. BULLPUP A: Solid propulsion; worheod, 250-lb. H.E. BULLPUP B: Pre-packoged liquid motor; worheod, 1,000-lb. H.E. STATUS: BULLPUP A deployed with Atlontic ond Pocific Fleets; operotionol with U.S. Air Force & NATO units; troining version (ATM-12) being procured by both services.

CORPORAL (MGM-5) (Army)—CONTRACTORS: Firestone, prime; ITT-Gilfillon, guidonce; Ryon, prapulsion. DESCRIPTION: Surfoce-to-surfoce; weight, 11,000 lbs.; liquid propulsion; worhead, nucleor; ronge, 75 n.mi.; guidonce, pre-set and commond. STATUS: Deployed in Europe; being replaced by SERGEANT.

DAVY CROCKETT (M-38B) (Army)—CONTRACTORS: In-house project directed by Army Weopons Commond ot Rock Island, Ill. DESCRIPTION: Surfoce-to-surfoce; solid prapulsion, bozooko-lounched; worhead, subkiloton nucleor; guidance, free flight; two lounchers—vehicle-mounted or corried by two men. STATUS: Operotionol in Europe; $13 million provided in FY '64 budget; 3 per ROAD bottolion; seen os defensive rother than offensive weopon to prevent overrun of Europe.

ENTAC (MGM-32) (Army)—CONTRACTORS: Nord Aviation, prime. DESCRIPTION: Anti-tonk; weight, 37 lbs.; solid prapulsion; warhead, shoped-chorge H.E.; ronge, 6,600 ft.; guidonce, wire-guided; mon-portoble. STATUS: Operotionol; Army buying from French in quontity to replace SS-10.

FALCON (AIM-4/26/47) (Air Force)—CONTRACTORS: Hughes, prime; Hughes, guidance; Thiokol, AIM-4/26 propulsion; Lockheed Propulsion, AIM-47 propulsion. DESCRIPTION: Air-to-oir; weight (AIM-4/47), more than 100 lbs.—(AIM-26), more thon 200 lbs.; ronge 5 n.mi.; supersonic; solid propulsion; warhead, H.E. (except for AIM-26); AIM-4A, ond 4E, octive rodor homing guidance; AIM-4B, 4C, 4D, ond 4F, IR homing; AIM-26 model has nuclear warhead ond hybrid IR rodor homing. STATUS: Operotionol; buy-out of 4E, 4F ond 26 in FY '62; AIM-47 under minimum effort development.

FLEET AIR DEFENSE MISSILE (Novy)—CONTRACTORS: None onnounced. DESCRIPTION: Surfoce-to-air. STATUS: Will replace stondordized missile and use technology from TYPHON progrom; fleet defensive weopons for 1970's.

GENIE (AIR-2) (Air Force)—CONTRACTORS: Douglos, prime; Aerojet-Generol, propulsion. DESCRIPTION: Air-to-oir; weight 800 lbs.; unguided; solid propulsion; worheod, nucleor; ronge, 6 n.mi.; guidonce, free flight; supersonic; proximity fuzing. STATUS: Procurement complete; operotionol on F-101B ond F-106; improved version cancelled.

HAWK (MIM-23) (Army)—CONTRACTORS: Roytheon, prime; Roytheon, guidonce; Aerojet-General, propulsion. DESCRIPTION: Surface-to-air; weight, 1,275 lbs.; solid propulsion; warhead, H.E.; ronge, 22 mi.; guidonce, semiactive rodor haming; 100-45,000-ft. ceiling; provides defense against medium ond low-flying oircraft ond cruise-type missiles. STATUS: Operotionol; deployed in Europe, Panama, Okinowa, U.S. (13 bottolions); bought by Sweden ond Isroel; R&D being conducted to odopt selected HAWK units to on onti-tocticol bollistic missile; NATO producing.

★HONEST JOHN (MGR-1) (Army)—CONTRACTORS: Douglos/Emerson Electric, prime; Hercules, prapulsion. DESCRIPTION: Surface-to-surface; weight, 5,900 lbs.; single-stage solid propulsion; worhead, nucleor; ronge, 12 mi. (M-31), 20 mi. (M-50); unguided. STATUS: Operotionol; M-50 being deployed in Europe; to be reploced by LANCE.

HOUND DOG (AGM-2B) (Air Force)—CONTRACTORS: North Americon, prime; Autonetics, guidonce; Pratt & Whitney, propulsion. DESCRIPTION: Air-breathing oir-to-surfoce stondoff missile; weight, 9,600 lbs.; turbojet propulsion; warheod, nucleor; ronge, obout 600 n.mi.; guidonce, oll-inertiol; ceiling in excess of 50,000 ft.; Moch 2+. STATUS: Operotionol; to be lounched from B-52G intercontinentol bombers; procurement complete.

LANCE (MGM-52) (Army)—CONTRACTORS: Ling-Temco-Vought, prime; Systron-Donner, guidonce. DESCRIPTION: Highly mobile generol-purpose missile; very light weight; pre-packoged storable liquid propellont; worhead, nucleor ond H.E.; ronge, 3-30 mi.; guidance, Automet inertiol, one missile per lounchar. STATUS: Large-scale development; eventuolly will reploce HONEST JOHN ond LACROSSE; division support weopon; to use multi-system test equipment.

LITTLE JOHN (MGR-3) (Army)—CONTRACTORS: Emerson Electric, prime; Hercules Powder, propulsion. DESCRIPTION: Surfoce-to-surfoce; weight, 800 lbs.; solid propulsion; worhead, nucleor; range, 10-mi.; unguided; supplements medium ond heavy ortillery in airborne divisions ond airtransportoble commonds. STATUS: Two battalions activated in 1961; eoch equipped with four lounchers; oir ond helicopter transportoble; moy be reploced by LANCE.

★LOW ALTITUDE SUPERSONIC VEHICLE (Air Force)—CONTRACTORS: Ling-Temco-Vought, nuclear vehicle components; AEC/Morquardt, nuclear ond chemicol technology; Lockheed, studies of chemical version. DESCRIPTION: Surfoce-to-surfoce, low-altitude; nuclear or chemical romjet; designed to conduct long oerial potrols ot speeds up to 2,000 mph. STATUS: Nucleor propulsion system being developed under project PLUTO; feasibility proven by TORY reoctor tests. Tory II-C tests to begin in early 1964; future of program beyond this time unclear.

M72 (Army)—CONTRACTORS: Hesse-Eastern Div., Flightex Fobrics, prime. DESCRIPTION: Light ontitonk rocket; weight, 4.5 lbs.; solid propulsion; worhead, H.E.; range, 500 yds.; guidonce, free flight; corrier tube lounchar; earlier called LAW. STATUS: Operotionol.

MACE (Air Force)—CONTRACTORS: Mortin, prime; Goodyeor/AC Spork Plug, guidance, Thiokol/Allison, propulsion. DESCRIPTION: Air-breothing surfoce-to-surfoce; weight, 18,000 lbs.; turbojet and solid propulsion; worhead, nuclear ond H.E.; range, over 650 n.mi. (Model A), over 1,200 n.mi. (Model B); guidonce, inertiol. STATUS: Five MACE-A and one MACE-B squadron deployed in Europe; two MACE-B squodrons on Okinawa in hard sites.

MATADOR (MGM-1C) (Air Force)—CONTRACTORS: Mortin, prime; Air Force, guidance; Thiokol/Allison, propulsion. DESCRIPTION: Air-breothing surfoce-to-surfoce; weight, 10,000 lbs.; turbojet ond solid propulsion; worhead, nucleor or H.E.; range, over 600 n.mi.; guidonce, MSQ rodor ond form of LORAN; speed, obout 650 mph.; ceiling above 35,000 ft. STATUS: Being turned over to West Germans; also deployed in Koreo and on Toiwon.

MAULER (MIM-46) (Army)—CONTRACTORS: GD/Pomono, prime; Hughes, guidonce; Lockheed, propulsion; deHavilland, IR ocquisition; Roytheon, rodar; Burroughs, computer; FMC, carrier vehicle. DESCRIPTION: Surfoce-to-air; weight, 120 lbs.; solid propulsion; warhead, nuclear, H.E.; guidance, IR ocquisition; highly mobile antioircraft and antimissile missile; trocked vehicle; 9 missiles per lounchar. STATUS: Development; suffering serious guidonce problems: Army postponing more odvanced models.

MINUTEMAN (LGM-30) (Air Force)—CONTRACTORS: TRW Space Technology Loboratories, systems engineering and technicol direction; Boeing, mojor contractor; Autonetics, guidonce; Thiokol, first-stoge propulsion; Aerojet, second-stage propulsion; Hercules, third-stage propulsion; Avco, re-entry vehicle. DESCRIPTION: 2nd-generation ICBM; weight, over 65,000 lbs.; solid propulsion; warhead, nuclear; 3 stages; ronge, over 5,000 mi.; guidance, all-inertial, torget selected in seconds; 32-sec. reaction time. STATUS: MINUTEMAN II under development; 450 MINUTEMAN I now

operational; 1,000 missiles through FY '65; advanced version con be fired by airborne command posts; deployed in hordened ond dispersed silos; MINUTEMAN II expected operotional 1965, to be co-located with MMI; also some af the II's reploce earlier models.

MOBILE MEDIUM-RANGE BALLISTIC MISSILE (Air Force)—CONTRACTORS: (development phase) Hughes, integrotion, ossembly ond checkout; Philco Aeronutronic, re-entry system; Thiokol, propulsion; Goodyeor Aerospoce Corp., transporter-louncher-erecter; Martin Morietto, commond ond control; Generol Precision, guidance. DESCRIPTION: Two-stage MRBM; weight, 11,000 lbs.; solid propellent; ronge, 1,100-2,000 mi.; guidonce, stellar-inertial; entire system contained in one mobile vehicle; STATUS: Lock of deployment objective or valid military requirement has caused Congress to cut $70 million from $110 million requested; if funds ore not restored, progrom will be cancelled.

NIKE-HERCULES (MIM-14) (Army)—CONTRACTORS: Western Electric, prime; Western Electric, guidonce; Hercules and Thiakol, propulsion; Douglos, airfrome. DESCRIPTION: Surface-to-air, antioircraft, tactical; weight, 10,000 lbs.; solid propulsion; worheod, nucleor or H.E.; ronge, 75-mi.; guidonce, commond; Mach 3+; ceiling in excess of 150,000 ft. STATUS: Over 80 botteries deployed in U.S. being turned over to Notionol Guard; aver 10 N-H botteries deployed overseos; being equipped with HIPAR, o high power ocquisition rodar, and onti-toctical-ballistic-missile capabilities.

NIKE-ZEUS (LIM-49) (Army)—CONTRACTORS: Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe. DESCRIPTION: Antimissile missile, 3-stage; weight, 22,800 lbs.; solid propulsion; warheod, nuclear; ronge, 200-mi.; guidance, commond; length, 48 ft.; diameter, 36 in.; fin span, 10 ft. STATUS: Missile to become port of NIKE-X missile "mix"; development, except as part of X, to end in FY '65; no intercept "failure" in more thon o yeor of tests.

NIKE-X (Army)—CONTRACTORS: Western Electric, prime; Bell Telephone, guidonce; Thiokol, ZEUS propulsion; Douglos, ZEUS airframe; Mortin Marietto, SPRINT missile prime; Hercules and Lockheed, SPRINT propulsion. DESCRIPTION: Most advanced portion of NIKE-ZEUS concept; uses a mix of ZEUS/SPRINT missiles ond multi-function orroy rodar (MAR). STATUS: Engineering development; funded ot $334 million in FY '65 on acceleroted development schedule, but deployment still deferred; tests to be conducted lote this yeor could provide basis for deployment decision; deployment costs: $12-20 billion.

★**PERSHING** (MGM-31) (Army)—CONTRACTORS: Mortin, prime; Bendix, guidance; Sperry Forrogut, fuzing and aiming; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; two-stage solid propulsion; warhead, nucleor; ronge, approx. 400 n.mi.; guidonce, intertiol; transported on FMC XM474 trocked vehicle; to reploce REDSTONE. STATUS: Flight test progrom completed; troop firings from Ft. Wingate, N.M., to White Sonds being conducted; number of launches per unit to be increased; West Germony orgonizing two bottolions; first U.S. PERSHING bottolion deployed to Germony in April.

★**PHOENIX** (AIM-54) (Navy)—CONTRACTORS: Hughes Aircroft Co., prime; Rocketdyne, propulsion. DESCRIPTION: Air-to-missile for use with the TFX fighter aircroft. STATUS: Development; olso to be tested for use on A-11 oircroft.

POLARIS (UGM-27) (Navy)—CONTRACTORS: Lockheed, prime; GE/MIT/Hughes/Honeywell/Roytheon, guidonce ond fire control; Aerojet-General/Hercules, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination ond training; Systron-Donner, ignition programming. DESCRIPTION: Underwoter- ond surface-to-surface; weight, 30,000 lbs.; solid propulsion; warheod, nuclear; ronge, 1,200 n.mi. (A-1), 1,500 n.mi. (A-2), 2,500 n.mi. (A-3); guidonce, oll-inertial. STATUS: 16 POLARIS subs reody for sea, 13 operatianal eoch with 16 missiles; A-T aboord first five submarines; A-2 operationol oboard subs 16-18; A-3 to be operotional in August 1964 oboord subs 19-23; total of 41 POLARIS subs authorized; 32 A-3 flight tests hove been conducted, 20 fully successful; deployed in Atlontic and Mediterraneon; Pacific servicing facilities being built; British to buy A-3 missiles from U.S. B-3 program defintion included in FY '65 budget.

★**QUAIL** (ADM-20) (Air Force)—CONTRACTORS: McDonnell, prime; McDonnell Electronics, guidance; GE, propulsion; Thompson Romo Wooldridge, ECM equipment. DESCRIPTION: ECM-carrying decoy which simulotes B-52 bomber to enemy radar; abaut 200 mi. ronge; turbojet powered; range, 250 mi.; guidance, gyroscopic outopilot. STATUS: Deployed ot SAC bases; corried by B-52; procurement completed FY '61; advanced version with 400-mi.-ronge hos been flight tested.

★**REDEYE** (MIM-43) (Army)—CONTRACTORS: GD/Pomona, prime; Hughes, IR seeker; Atlontic Reseorch, propulsion. DESCRIPTION: Surfoce-to-oir; weight, 22 lbs.; solid propulsion; worheod, conventional; guidonce, IR-homing; length, 44 in.; diameter, 2.75 in. STATUS: House disopproved FY '65 procurement request; could be restored by Senote; growth versions planned.

REDSTONE (PGM-11) (Army)—CONTRACTORS: Chrysler, prime; Sperry Forrogut, guidonce; Rocketdyne, propulsion. DESCRIPTION: Surfoce-to-surface; weight, 62,000 lbs.; liquid propulsion; worheod, nucleor; ronge, 200 mi.; guidonce, inertiol. STATUS: Deployed in Europe being reploced by PERSHING.

★**REGULUS I** (RGM-6) (Novy)—CONTRACTORS: Ling-Temco-Vought, prime; Sperry, guidonce; Allison, propulsion. DESCRIPTION: Surfoce-to-surfoce; weight, 14,000 lbs.; turbojet ond solid propulsion; worheod, nucleor; ronge, 500 n. mi.; guidance, inertial; speed, obout 600 mph; ceiling, opprox. 40,000 ft. STATUS: Five REGULUS subs ore operotionol now; 3 subs (8 missiles) will be phased out in FY '65.

SERGEANT (MGM-29) (Army)—CONTRACTORS: Sperry Utoh, prime; Sperry guidonce; Thiokol, propulsion. DESCRIPTION: Surfoce-to-surfoce; weight, 10,000 lbs.; solid propulsion; warhead, nuclear; ronge, over 75 n. mi.; guidance, inertiol; uses drag brokes. STATUS: Operationol; deployed in Europe; replacement for CORPORAL; West Germony buying system.

★**SHILLELAGH** (MGM-51) (Army)—CONTRACTORS: Philco Aeronutronic, prime; Picotinny Arsenol/Amoco Chemicols Corp., propulsion; Aeronutronic, guidance. DESCRIPTION: Surfoce-to-surfoce; lightweight; solid propulsion; worhead, nucleor or H.E.; guidonce, commond; vehicle-mounted for use against field fortifications, ormor ond for close-in support of troops. STATUS: Initiol procurement in FY '65; to use multi-system test equipment; engineering development stoge begon in FY '64; to be instolled on Gen. Sheridon ossoult vehicle; olso being considerd for us on helicopters.

SHRIKE (AGM-45A) (Novy)—CONTRACTORS: Novol Ordnonce Test Stotion-Chino Loke, prime; Texos Instruments, guidonce ond control; North American Rocketdyne (McGregor), propulsion. DESCRIPTION: Air-to-surfoce, onti-radar; solid prapulsion; guidonce, possive rodor homing; formerly ARM. STATUS: Operotionol; ormoment for Navy ond Air Force tocticol oircroft.

SIDEWINDER (AIM-90) (Novy, Air Force)—CONTRACTORS: Noval Ordnonce Test Statian, technical direction; Philco, guidonce; Novol Ammunition Depot, McAllister, motor looding; Rocketdyne (McGregor), propellont. DESCRIPTION: Air-to-oir; weight, obout 155 lbs.; solid propulsion; worheod, H.E.; ronge, more than 2 mi.; guidonce, IR. STATUS: 1A deployed with Novy ond Air Force; 1-C version being procured os replocement for 1A; NATO-built version now in production.

SPARROW III (AIM-7E) (Novy)—CONTRACTORS: Roytheon, prime; Roytheon, oirfrome, control, guidonce; Aerojet-Generol/Narth Americon Racketdyne (McGregor), propulsion; McDannell/Benrus Wotch Co., louncher. DESCRIPTION: Air-to-oir; weight, 350 lbs.; solid propulsion; worheod, conventionol; ronge, 5-8 mi.; guidonce, semi-octive CW homing; Moch 2.5-3; ceiling, over 50,000 ft. STATUS: Eorlier models aperotionol with carrier oircroft; SPARROW III B-6B prime ormoment for Phontom II (F-4B) ond other high-perfarmonce interceptors.

★**SPRINT** (Army)—CONTRACTORS: Mortin-Orlondo, prime; Hercules Powder/Lockheed Prapulsion Co., propulsion; Bell Telephone Loborotories, guidonce. DESCRIPTION: High-occelerotion missile for law-oltitude interception af bollistic missiles; to be port of the missile mix in o NIKE-X bottery. STATUS: Develapment; SQUIRT vehicle to be used to test materials ond components for SPRINT ot White Sonds Missile Ronge.

★**STANDARDIZED MISSILE** (Navy)—CONTRACTORS: Baeing, GE, Hughes, ITT, Philco, Raytheon, Sperry Rond, Sylvonio, RCA, Westinghouse & NAA invited to bid on missile, rodor and lounch equipment. DESCRIPTION: Surface-to-air. STATUS: Ta be standard replacement for TALOS, TERRIER and TARTAR; bids were due to Novy in April; selection of contractors expected by July 1 for progrom definition.

SUBROC (UUM-44) (Novy)—CONTRACTORS: Novol Ordnonce Loborotory, technical direction; Goodyeor, prime; Generol Precision Aerospoce, guidonce; Thiokol, propulsian; Generol Precision Librascope, fire control. DESCRIPTION: Underwoter-oir-underwoter antisubmarine missile-depth bomb; solid propulsion; worheod, nucleor; ronge, 25-30 mi.; guidance, inertiol. STATUS: Praduction; scheduled for instollation in Thresher-closs subs; will be aperatianal this year.

SS-10 (Army)—CONTRACTORS: Nord Aviotion, prime; GE, U.S. licensee. DESCRIPTION: Surface-to-surface, primarily ontitank; weight, 33 lbs.; salid propulsian; warhead, conventianal; ronge, 1,600 yards; wire guided. STATUS: Operationol with U.S., French ond other NATO ond Western units; battle-tested in North Africo; U.S. replocing with ENTAC.

SS-11 (Army)—CONTRACTORS: Nard Aviotion, prime. DESCRIPTION: Surface-to-surfoce ontitonk, also helicopter-to-surfoce; weight, 63 lbs.; solid propulsion; wire guided; warhead, conventional; ronge, 3,800 yds. STATUS: Operationol, to be used with airborne units ond Army helicopters.

TALOS (RIM-8) (Navy)—CONTRACTORS: Bendix, prime; Vitro, systems engineering; Bendix/McDonnell/Hercules Allegany Ballistics Lab., propulsion; Sperry, guidonce; GE, launching geor. DESCRIPTION: Ship-to-oir; weight, 7,000 lbs.; solid ond ramjet propulsion; warheod, nucleor; ronge, 65 n. mi.; guidonce, rodar beom riding/semi-octive haming; Moch 2.5. STATUS: Operotionol oboord cruisers Galveston, Oklohoma City ond three heovy cruisers; Long Beoch, nucleor-powered cruiser, hos odvanced TALOS; "3-T" get-well program increasing reliobility.

TARTAR (RIM-24B) (Novy)—CONTRACTORS: Vitro, systems coordinotion engineering; Applied Physics Lob, design ond development; GD/Pomona, ossembly ond test; Roytheon, guidance; Aerojet-Generol, prapulsion (motor looding); Sperry Forrogut, fuze (torget detectian device). DESCRIPTION: Ship-to-oir; weight, 1,500 lbs.; solid duol-thrust motor; worheod, conventionol; range, 10 n. mi.; guidance, beam-riding; Moch 2. STATUS: Operationol; installed obaord 15 guided missile destroyers ond cruisers equipped with TALOS; get-well progrom progressing sotisfoctorily.

TERRIER (RIM-2) (Novy)—CONTRACTORS: Vitro, systems engineering; GD/Pomono, prime; GD/Pomono, guidonce section; Sperry, rodor; Hercules Allegony Bollistics Loboratory, propulsian; Narthern Ordnonce, lounching gear. DESCRIPTION: Ship-to-oir; weight, 3,000 lbs.; 27 ft. long; solid propulsion; warhead, conventional; range 10 n. mi.; guidance, rador beam-riding or haming; Mach 2.5. STATUS: Operational aboard twa ottack carriers, 6 cruisers, ond 12 missile frigotes; get-well progrom progressing sotisfactorily.

TITAN I (HGM-25) (Air Force)—CONTRACTORS: TRW, Spoce Technology Lobarotories, systems engineering ond technical direction; Martin, prime; Bell/Sperry, guidonce; Aerojet-General, propulsion; Avco, re-entry vehicle. DESCRIPTION: ICBM; weight, 220,000 lbs.; LOX/RP-1 fueled; worhead, nuclear; range, 5,000 mi.; guidonce, radio inertiol; 90 ft. long; 2 stoges. STATUS: Operationol; 54 missiles at 5 boses.

TITAN II (LGM-25) (Air Force)—Martin, prime; TRW Spoce Technology Loborotories, system engineering ond technicol direction; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle. DESCRIPTION: ICBM; weight, 330,000 lbs.; N_2O_4 and Aerozine-50 storable fuels; worheod, nuclear; range, over 5,000 mi.; guidonce, inertial; 115 ft. long; 2 stages; greatest poylaad and range af any U.S. ICBM; bosic core vehicle for TITAN III booster. STATUS: All 54 missiles operationol; one squodran (18 missiles) operationol at Dovis-Monthan AFB; one (18 missiles) ot McConnell AFB ond one (18 missiles) at Little Rock AFB.

TOW (Army)—CONTRACTORS: Hughes, prime. DESCRIPTION: Antitank; solid propulsion; worhead, H.E.; wire guided; opticolly trocked; tube-launched. STATUS: Development; follow-on to ENTAC.

ZUNI (Novy)—CONTRACTORS: Noval Ordnance Test Station, prime; Hunter-Douglos, propulsion. DESCRIPTION: oir-to-surfoce; weight 107 lbs.; solid propulsion; worhead, conventionol; ronge, 5 n.mi.; unguided; STATUS: Operationol; designed for use on jet fighter ond attack aircraft.

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CORPORATION

Technical Countdown

PROPULSION

AF Arc Jet Engine Reaches 500 Hours

An experimental 30-kw arc-jet engine has run continuously for 500 hours in a test at the Air Force Aero Propulsion Lab, Wright-Patterson AFB. The 10-lb. hydrogen unit was built for the Air Force by Giannini Scientific Corp. for $350,000. The regeneratively-cooled engine suffered no deterioration in the 500-hr. qualification test and further tests may extend the total running time to more than 1,000 hours. The unit has an Isp of 1,000 seconds and an efficiency of 35%. The Aero Propulsion Lab is an element of the Research & Technology Div., based at Bolling AFB.

Thiokol Fires Shook-Up Minuteman Stage

A *Minuteman* first stage motor subjected to intensive vibration tests at Thiokol Chemical Corp.'s Wasatch Div. has been successfully fired. The fully loaded motor was completely instrumented with sensing devices embedded in the grain. The test facility put the motor through more than 1.5 million cyclic loads ranging from 0.25 to 3 "g's" acceleration. The longitudinal, transverse, bending and breathing resonance frequencies, mode shapes, and relative motion of the propellant grain, propellant star tips, components and the steel case were determined from the acquired data. The included instrumentation did not degrade the motor's performance during the firing.

Aerojet Attitude Rocket Passes 70,000 Restarts

A 25-lb.-thrust attitude-control rocket designed and built by Aerojet-General's Liquid Rocket Operation has logged a total firing time of 5,000 seconds. Exactly 70,000 restarts were made through constant repetition of the duty cycle forecast for *Gemini*. Aerojet spokesmen claim the flight-weight system embodies a new approach to attitude control systems and has a design goal of 10,000 seconds duration. The 5,000-second mark passed without signs of degradation in the chamber and other components.

MATERIALS

ATJ Graphite Stronger at 6,000°

The first known measurements of the tensile strengths of ATJ graphite at 6,000° and 6,500°F indicate the material retains about 75% of its room temperature strength. The 50,000-psi levels found by Southern Research Institute scientists is considerably higher than that predicted by extrapolation from data at 5,000°F. Total strains were large, and strength was quite dependent on strain rate. The Birmingham, Ala., research firm will continue to study the properties of materials at these high temperature ranges. The furnace, developed as part of an AEC project at SRI, may be capable of reaching 7,000°F in its relatively large, passive hot zone. Properties under study include compressive strengths, tensile and compressive modulus, thermal expansion and thermal conductivity. Materials include graphites, carbides and other ceramics.

LOX Supply Capabilities Tested

The Linde Div. of Union Carbide Corp. has delivered 2,000 tons of liquid oxygen to the F-1 test stand complex at Edwards Air Force Base in a 24-hour test period. The mammoth LOX movement was conducted jointly by NASA, Linde, Rocketdyne and the Air Force through the Director of Aerospace Fuels. The test was run to see if Linde could meet the LOX requirements for NASA's accelerated F-1 engine test program. Edwards' ability to transfer 2,000 tons of LOX into storage vessels within a 24-hour period was also part of the test. NASA has programmed 76 F-1 firings, and a full-duration run of 150 seconds with the engine will consume 500 tons of liquid oxygen.

Cement Used In Titanium Machining

Martin Co. technicians are using a gypsum cement to hold titanium tankage parts for the *Titan III* transtage vehicle during crucial machining operations. The metal tends to continuously move since it is brittle when cooled and malleable when heated. With the aid of the cement, components such as the oxidizer tank cone section are machined from a 0.5 in. wall thickness down to a 0.096 (±0.005) in. thickness. Both the 4 x 13.5 ft. fuel tank and the 5 x 11 ft. oxidizer tank are titanium. Each consists of seven components forged by Ladish Co. from Ti-6A1-4V.

ELECTRO-OPTICS

Fast, Wide-Angle Lens Developed

A new rugged surveillance lens system, developed for optimum response to moonlight on an S-20 photocathode, provides a speed of f/0.8 with a 40-degree field angle. Now obtainable from the J. W. Fecker Division of American Optical Co., Pittsburgh, the Model 136 Hytar is designed for remote focus adjustment and iris setting using separate dc motor drives. Resolution of the 8-lb., 7½-in.-dia. system is 100 lines/mm. (on axis). Speed is adjustable to f/16, Fecker says; the effective focal length in 44 mm. and focal range is from 7 ft. to infinity.

Laser Beam Deflected Electronically

Deflections of a laser communication beam up to 30 times beamwidth have been achieved electronically by General Telephone & Electronics Laboratories, Inc. The technique, developed in-house, satisfies a prerequisite to practical laser space communications, the company says. In the GT&E Lab method, a polarized laser beam is passed through a crystal whose index of refraction can be varied linearly by the application of an electric field. The resulting energizing wave front is tilted and the laser beam is thus deflected by an angle proportional to the crystal length and applied voltage. The technique has resulted in a recent NASA contract to the lab to continue its research in an attempt to further increase the deflection capability. Up to 100 times beamwidth deflection will be possible within a few months, a lab spokesman said.

Study Awards Near for 3-Module MOL

by Willard E. Wilks

THE AIR FORCE Space Systems Division hopes to issue requests for proposals on its *Manned Orbiting Laboratory* (*MOL*) program in October or November, following completion of 14 or more industry study contracts to define systems and assess military and other experiments.

The Division is moving to award the study contracts "as soon as possible" following the Dept. of Defense's May 1 release of $5 million for this purpose.

Meanwhile, spokesmen told MISSILES AND ROCKETS the *MOL* plan calls for a modular approach to the laboratory—three compartments each 10 ft. long. Two of the compartments will be pressurized; in case one fails, the crewmen can complete their mission in the other. The third compartment will contain equipment.

Top SSD sources believe this building-block configuration will satisfy reservations expressed in some quarters about *MOL's* mission time and crew-size growth potential.

● **Uncertainties**—The release of study contract funds came as competition among small, medium and large space station concepts shifted into high gear and as pessimism over *MOL's* ultimate fate mounted in industry and the Air Force. While the cost-conscious Johnson Administration has not stated so specifically, indications are that *MOL* may have to compete with NASA's space station proposals for selection as a single concept to serve military and civilian program needs.

Recent formation of the National Space Station Planning Sub-Panel of the joint NASA/DOD Aeronautics & Astronautics Coordinating Board has added to the feeling that *MOL* may be headed for the national space station playoffs. The group is to determine the optimum configuration for what is called the National Space Station Program, to establish its cost, to decide which agency should manage the project, and to recommend concepts that will make maximum use of existing hardware.

It is against this background that *MOL* is being compared with NASA concepts; its chances of reaching development stage are being questioned by industry experts engaged in company and NASA-funded studies of small, medium and large orbiting laboratories. These observers don't believe that the Administration will buy two space station programs—unless it is possible to proceed with *MOL* as an early minimal approach which will serve pressing military needs and later become an element of a larger station, perhaps a logistics vehicle.

● **NASA objections**—The following points reflecting NASA's views, are raised:

—Thirty days stay-time is not long enough to determine zero-g effects on man for the longer missions NASA has in mind, and feasibility extending the capability of *MOL* is questioned. One spokesman added that the *Titan III-C* payload capability "already is getting marginal."

—A two-man crew is not large enough to establish in good time a valid statistical base for determining man's long-term capability in space. The effect of zero-g may vary considerably among individuals.

—From a cost/effectiveness standpoint, larger concepts are more attractive. Some typical NASA studies conducted by Lockheed and Douglas show that a station with 4 to 6 men, with at least 4 month's mission time and based on existing technology and NASA boosters, would cost little more than *MOL*—around $1.5 billion.

● **Air Force reply**—Answering these points, a high-level Air Force spokesman told M/R that the modular approach should provide an inherent ability to stretch *MOL* both in stay-time and crew size. For the projected rendezvous operations downstream in the program, this configuration would allow modules to be ferried into orbit as needed following establishment of the initial *MOL*. It also would provide redundancy for a larger station and permit flexibility in the resupply operation.

As a safety factor, crew module design provides life support for double the planned 30-day mission time, "so we don't see difficulty in providing an inherent ability to stretch *MOL's* mission time wthout resupply," a spokesman said.

SSD plans incorporate the possibility of taking advantage of the building block configuration to build a larger station in orbit. This, however, lies some time in the future. Present plans call for procurement of about six *MOL* vehicles.

As for the cost/effectiveness argument, AF sources declared *MOL* should prove cheaper than NASA-funded studies now indicate when comparing *MOL* with other small and medium sized laboratories. They estimated cost of *MOL* at around $1 billion, and added that they anticipated a cost of about $50 million per launch, including the *Gemini* vehicle, the laboratory and booster (but not including development cost), as against some $200 million for other concepts.

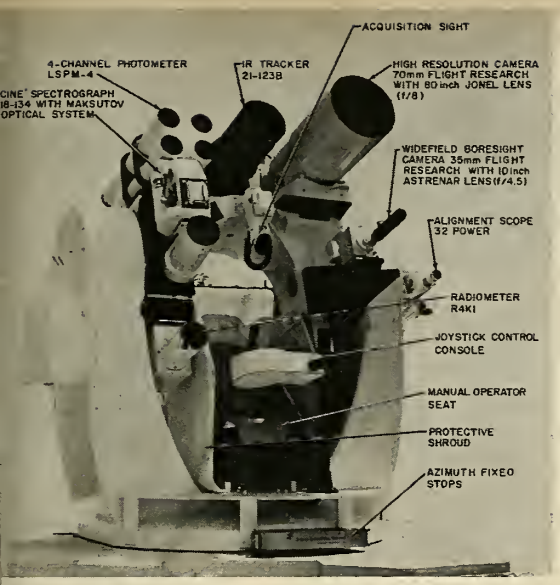
The $1-billion estimate is the same as that reached in NASA-funded studies. But these studies also calculate $1.5 billion for a medium-size *Manned Orbital Research Laboratory* (*MORL*) carrying 4-6 men.

● **Martin, McDonnell "in"**—Study contracts on the integration and interface problems will go to the Martin Co. and McDonnell Aircraft Corp., both automatically involved in the program through their work on *Titan III-C* and *Gemini*. Martin is expected to be system integrator, since it is responsible for this in the *Titan III-C* and *Gemini* programs.

The major new hardware contract in the program will be that for the laboratory. A single prime will be selected, according to spokesmen.

Six to eight studies will define the military and other experiments the program will conduct. Subjects of these include navigation experiments to determine what man can do and what equipment he would need for development of a self-contained system; rendezvous and satellite intercept; and what kinds of observation are possible on the parts of astronauts, including the possibility of surveillance of other bodies and gathering of meteorological data.

"Our overall objective in this pre-Phase I period is to come up with the best RFP that we can, one that really defines the system," the spokesmen said. The pre-Phase I period will require six months, during which the studies will be completed. This will be followed by RFP's. Six to eight months will be required for selection of the full team, and another six to nine months before a go-ahead can be obtained. Observers, pointing to the period required for release of the study funds following assignment of *MOL* to Air Force last December, said the time could be compressed if fast action at higher levels could be obtained. The development period will require 27-30 months and cannot be compressed. ■



ELECTRO-OPTICAL instrumentation for use in Project Dazzle.

'Dazzle' Flights Slated To Check Instrumentation

Barnes, Stanford Research systems to track British-built re-entry vehicles at Woomera

by Michael Getler

NEW YORK—British-built *Black Knight* research missiles with instrumented payloads are being launched at the Woomera Missile Range in Australia to check out newly installed optical and RF re-entry measurement ground instrumentation as a prelude to full-scale testing in the joint U.S.-U.K.-Australian Project Dazzle.

Several of these "preliminary" firings have been made since the first launching earlier this year.

While the Dazzle project is being run at Woomera and is using U.S.-supplied re-entry measurement systems, the airborne phase of the program is mostly British show, combining the highly serviceable *Black Knight* and new British-designed re-entry vehicles. No U.S. vehicles will be flown.

Details on the re-entry shapes to be flown are closely guarded, but some observers speculate that at least a portion of the testing may contribute data to be used by the British in designing their warhead for the *Polaris* missile, which in a few years will be aboard that nation's fleet ballistic missile submarines.

The two-stage *Black Knight* will loft its payload several hundred miles above the Woomera range, but at relatively high launch angles that will restrict re-entry tests to comparatively short ranges to permit more accurate optical data collection. Woomera has a maximum overland range of 1,250 miles, but the *Black Knight* tests will be limited to roughly 575 mi.

The second stage of the vehicle will be used to propel the re-entry shape back into the atmosphere at high speed. The second stage will probably be ignited at an altitude slightly below 200 mi., with the bulk of the high-speed re-entry phenomena recorded as the payload descends through the 300,000 to 200,000-ft. altitude levels.

● **Yankee role**—U.S. participation is being handled by the Dept. of Defense's Advanced Research Projects Agency (ARPA). But the tri-nation Project is not considered as part of ARPA's Project Defender and reportedly does not duplicate U.S. efforts.

Two U.S.-provided ground-based systems will handle the bulk of the re-entry data, obtaining measurements in the RF, ultraviolet, visible, and infrared portions of the spectrum.

Measurement of re-entry wake response at various RF frequencies will be made with a new high-power radar developed by Stanford Research Institute.

The UV, IR, and visible data is provided by two unique electro-optical measurement and tracking laboratories developed by the Barnes Engineering Co., Stamford, Conn. The labs—each of which includes a servo-driven pedestal mounting about 800 lbs. of instrumentation and a van housing the recorders and associated electronics—have been postponed at the launch and re-entry positions of the range for the *Black Knight* tests to provide data collection at different look-angles.

During a flight, the two systems function as a coordinated unit integrated with range operations, with communications between operators at both sites and range central control. Should slaving be required, Barnes reports, range-tracking FPS-16 radar provides acquisition data to both sites through a parallax-correcting computer.

● **Three types**—In the Barnes system, three basic types of measurement equipment are provided: photographic, spectrographic and radiometric-photographic; spectral wavelengths cover the range from UV (0.28 micron) to long-wavelength IR (15 microns). Radiometric and spectrographic intensity measurements are recorded on film, chart-pen recorders, and on a multiplex tape recording system compatible with post-flight computer processing.

A 35-mm boresight camera and a 70-mm high-resolution camera with an 80-in. f/8 Jonel lens system comprise the photo equipment providing a filmed record and detailed closeup view of the re-entry phenomena.

A UV or IR cine spectrograph records spectral features of the target. Temperature and chemical changes of material in the re-entry bodies as they heat or burn in the atmosphere are detected by a high-speed movie camera, with spectral dispersion achieved by a transmission grating in front of the lenses.

Radiant emission in the narrow-band spectral range of 0.28-0.70 micron, according to Barnes, are measured by a 4-channel photometer. A 4-in. aperture radiometer has selectable detector-preamplifier packages that detect rays in the 1.815 micron region, while a 12-in. radiometer operates in the 2.8-5 micron band.

An IR tracking system is integrated with the pedestal drive to provide automatic target tracking, providing target position error signals and radiation intensity information. ■

Fund Cuts Crimp German Space Push

Hanover Air & Space Show presents ambitious national program that is likely to remain conceptual at present spending levels

by Frank G. McGuire

HANOVER, W. GERMANY—A very thin veneer of money covers a multitude of projects and ideas in West Germany's efforts to regain a technical lead in Europe. Shown at the Hanover Air and Space Show were numerous models depicting new booster stages, satellite payloads and component designs—most of which will remain models.

German space scientists are dismayed that their industry-wide request for at least Deutschemarks (DM) 140 million (about $35 million) to support a purely national space effort was cut to only DM 40 million, and is expected to be cut to about DM 18 million for the upcoming year unless something drastic occurs.

Thus, the German national program is modest at best, and far below the level of the European Launcher Development Organization (ELDO) program, to which Germany contributes more than 22%.

● **Thor-Ophos**—The most likely vehicle to be used in placing national payloads into orbit by Germany is a combination of *Thor* and an upper stage known as *Ophos*. This combination is expected to orbit an astronomical satellite, a communication satellite and more advanced payloads using electric propulsion based on nuclear power.

Informal discussions have already been held between Douglas Aircraft Co. and the U.S. government, as well as by German industry with its government, for the sale of *Thor* boosters to West Germany. It is understood that agreement has been reached in principle, but details have yet to be worked out. In the model shown here, both the U.S. and West German flags were painted on the side of the booster, indicating the possibility of U.S. cooperation in the program.

Coordination of German space efforts is handled by a small group known as ASAT (Arbeitsgemeinschaft Satellitenträgersystem) based in Munich. The *Ophos* stage, most of which is built by Bölkow, is a hydrogen/oxygen system for use with boosters such as *Blue Streak, Thor* or either of these with a second stage as well as *Ophos*. First booster may use *Blue Streak* and a second, undesignated, stage.

● **Ophos details**—The single-engine stage is designed to use liquid hydrogen and LOX in a very short structure. The Germans, hoping to use Woomera as a launch site, have kept the stage length as short as possible to eliminate any need to modify launch pads.

To keep a short length, they have designed the oxidizer tank as a torous surrounding the bottom of the fuel tank. This gives a total stage length of 14 ft., while the diameter is identical to that of *Blue Streak* at 10 ft. The Bölkow-produced engine is a turbopump-fed system with 30,000 lbs. thrust, while each of two verniers has 220 lbs. thrust.

Bölkow engineers said the stage is designed to push payloads above escape velocity, and the total payload weight involved would depend on the second stage chosen. *Ophos* has a loaded weight of eight metric tons.

● **Ophos 1E**—A follow-on project to *Ophos,* one not restricted by stage-length considerations, is the *Ophos 1E,* a fluorine/hydrogen stage designed for use with the *Thor* booster. This design does not use the torous tank approach, but otherwise is similar to the initial *Ophos* layout. It is about 12 ft. long, 6 ft. dia., and weighs 3.8 metric tons.

Theoretical vacuum specific impulse is 474 seconds, but an effective level anticipated in the German calculations is closer to 450 seconds. Thrust is about 38,500 lbs.

Used with the *Thor* booster, *Ophos 1E* will be launched from Vandenberg AFB in California with payloads of astronomical satellites, communications satellites and similar applications.

● **U.S. hardware**—Although little really new space hardware was shown by non-German firms at the show, British and French and American companies exhibited various systems, components and concepts.

An exception to the trend was North American Aviation's showing of its *Cyclops* air-to-surface missile for fighters and fighter-bomber aircraft. *Cyclops* is an unsophisticated weapon for installation on conventional aircraft armaments pylons without modifications.

Positive visual target identification is possible through a "unique" television guidance system. Weight of the explosive payload is 250 lbs. and launch weight is 560 lbs. Range with a sea-level launch is about 10 n. mi., while a launch at 30,000 ft. extends range to a maximum of 30 n. mi. The weapon is approximately 10 ft. long, 1 ft. dia., and has a wingspan of almost 3 ft. It uses solid rocket propulsion.

North American says development and testing can be completed in 12 months on the in-house project, and weapons can be delivered within two years. Defense Department has not yet bought the concept, and it is possible that *Cyclops* is a system too similar to Navy's *Walleye* television-guided missile to be of sufficient interest to DOD. The *Cyclops* design, says NAA, is inexpensive and reliable, making it highly attractive to foreign governments.

Applications of *Cyclops* include anti-radar missions, antitank, anti-personnel, or other air-to-surface attacks.

● **German national program**—Although the ELDO third stage being developed by Germany was displayed at Hanover, the bulk of large-scale space hardware shown was aimed at demonstrating the variety of ideas being developed under a national banner so that the country remains abreast of technology.

There is no Ministry of Aviation or other counterpart to NASA in the present governmental setup here. Work is carried out by a number of ministries, including the Ministry of Scientific Research, Ministry of Defense, Ministry for Traffic, Ministry of Economics, Ministry of Mail Service and Communications, as well as other agencies.

Coordination between NASA and various ministries has been carried out, and Program 625A is a joint German-U.S. program for putting a German payload in space aboard a *Scout* booster sometime in 1966. The overall national program is termed 625B, the multi-purpose satellite program.

Principal objective of the national effort is to concentrate on space projects not being emphasized by the U.S. and USSR, such as ground-launching of satellite payloads from rails, frequently re-usable sounding rockets, and large boosters using recoverable stages. ■

Spacecraft Re-usability Emphasized at Douglas

SANTA MONICA, CALIF.—Douglas Aircraft Company is making re-usability one of its main arguments in advanced booster and spacecraft studies.

The effort is divided into vertical and horizontal landing vehicles, with the Missile & Space Systems Div. (MSSD) responsible for the vertical approach and the Aircraft Div. in Long Beach, Calif., working on horizontal launch and landing concepts, similar to an aerospace plane.

An advanced programs official in MSSD reports re-usability "is the basis of our whole approach, though our eggs are not all in one basket. I'm pretty well convinced that we will see re-usable boosters in the next generation after we have gone through the expected *Saturn* booster improvement program."

● **The master plan**—MSSD has what one spokesman calls a master plan for development of a variety of re-usable booster proposals. Currently under way is a complete analysis of the mission potential for re-usable boosters in which the division seeks to develop a hard case for the concept.

In this, a major effort is aimed at development of a vehicle concept in which a single vehicle approaches the operational flexibility of a transport aircraft, for both civilian and military applications. It would be capable of delivering a complete hospital to a disaster area, a battalion of troops to a brushfire war, or injecting itself into orbit as a re-usable (recoverable) space station. Larger versions would be used for lunar "space truck" shuttles and manned interplanetary flight.

The concept envisions a system that is land-recoverable, equipped with four legs, and capable of using its main propulsion system, or segments of it, for both de-orbiting and terminal retro-thrust all the way to the ground, thus providing a vehicle able to land on the Moon as well as on the Earth.

The re-usable approach is being applied to both chemical and nuclear systems being investigated by Douglas.

● **ROMBUS concept**—The main effort at MSSD is centered around the *ROMBUS* (*Re-usable Orbital Module Booster Utility Shuttle*) single-stage-to-orbit concept, which grew out of Douglas' post-*Saturn* study for NASA. Based on unconventional structures and materials applications, the *ROMBUS* incorporates parallel rather than tandem staging to avoid the prohibitive vehicle lengths and excessive bending moments encountered when extrapolating tandem vehicles to a post-*Saturn* size booster.

Key to the approach is upgrading of mass fraction and specific impulse to achieve a vehicle of 1 million lbs. payload to orbit capability with a gross weight of half that possible with the conventional approach. One such conceptual vehicle has an 80-ft-dia. center body containing a liquid oxygen tank surrounded by eight liquid hydrogen tanks.

In addition to parallel arrangement, it incorporates titanium honeycomb sandwich construction and up to 12 advanced liquid oxygen/liquid hydrogen engines clustered around a plug nozzle that can be cooled with the hydrogen to permit a base-first re-entry.

Douglas reports the concept is adaptable to any of the advanced engine configurations being investigated by major propulsion contractors, including Aerojet's M-1, Pratt & Whitney's 3,000-psi concept, and Rocketdyne's toroidal segmented combustion chamber approach.

● **Vehicle versatility stressed**—A large part of the Douglas effort is devoted not only to devising a number of mission applications for *ROMBUS* but payload flexibility in a single vehicle. For example, a booster developed to carry an 800,000-lb. payload to orbit could be used for half that by filling the liquid oxygen tank to only 78% of capacity and dispensing with two of the liquid hydrogen tanks.

Thus a single vehicle could be used to transport troops or supplies on Earth, or payloads to orbit or to a lunar base.

The latest *ROMBUS* variation under investigation is a re-usable space station in the 200,000-lb. payload class in which the big spherical LOX tank would be used for crew and laboratory space.

One re-usable spacecraft study at MSSD has conceived a manned, maneuvering re-entry logistics and ferry vehicle using a replaceable or repairable thermal protective shell.

In this concept, the protective shell, fiberglass covered with ablative material, would be put to structural use, providing an external lifting body shape while sustaining aerodynamic pressure and heat loads during exit and re-entry.

A study has concluded that use of the ablative layer as a stiffening element in the shell wall offers weight savings for load-critical portions of the structure, since maximum wall loadings are experienced during the pad and boost phases when the ablative layer with an outer cover is still intact.

● **Answering the critics**—Some critics of Douglas' re-usability ideas accuse it of "far-out" thinking or at least being a little ahead of its time in the early stages of the space age when there are not enough missions to justify concern about re-usability.

But Douglas spokesmen say that if its thinking is 10 years ahead of time, "we cannot wait for 10 years before we start work." They estimate a single-stage-to-orbit vehicle could be developed in 10-15 years, depending upon priority.

The vehicle must be land-recoverable for greatest flexibility.

The concept has survived considerable critical examination by NASA, according to spokesmen.

Much of the skepticism is based on the argument that it wouldn't pay to recover boosters because the cost of launch operations consumes most of the total program cost, and the cost of booster airframes is relatively small.

According to Douglas analysis, the cost of the booster airframe would account for about 65% of the entire direct operating cost of re-usable boosters, with propellants accounting for about 5% and launch operations, including retrieval and refurbishment, for the remaining 30%.

The analysis compared two vehicles that were identical except that one was an expendable booster, and the other was re-usable. The weight of the recovery system incorporated in the latter, 147,000 lbs., was subtracted directly from the payload, leaving a capability of 320,000 lbs. to orbit.

Comparing cost effectiveness of the two approaches, on the basis of injecting 64 million lbs. into orbit over a 10-year period, it was found the expendable booster offered advantages that included a launch rate only two-thirds that of the re-usable vehicle, fewer fabrication facilities, less research and development cost, lower fabrication cost, and no recovery and refurbishment cost.

According to the Douglas figures, however, the re-usable booster could perform the same total weight-lifting program at about half the direct operating cost of the expendable version, since only 27 re-usable vehicles would be required for the job against 139 expendable boosters. ■



THE PRACTICAL MEN AND THE ROCKET ENGINE Today's giant rocket engines have existed for ages. But only in imagination, for tangible construction awaited a new breed: the practical engineers of aerospace.

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The Industry Week

Mergers and Acquisitions

Informatics, Inc., Los Angeles, has acquired the Advanced Information Systems Div. of Hughes Dynamics. The division's staff will transfer to Informatics to continue work on existing contracts in areas of information systems analysis and digital computer programming. Informatics provides analysis, design and consulting services for users of digital processing equipment. . . . *A group of former employees of the Norris-Thermador Corp., Alhambra, Calif., has acquired N-T's Electronics Div. and formed a new company under the name of Spatron, Inc. The company will continue to manufacture electronic components for military and industrial use.* . . . Superior Valve & Fittings Co., Pittsburgh, Pa., has purchased The McIntire Co., Livingston, N.J., manufacturer of industrial filters, purification and air-drying equipment. McIntire will be operated as a wholly owned subsidiary of SVF at its present location. . . . *Universal Manufacturing Co., Winona, Minn., has purchased Rez-Coat of California, Inc., Orange, Calif. Universal produces plastic compounds and heat-resistant materials for missile/space and commercial uses. Rez-Coat is a plastics manufacturer.* . . . Fairchild Stratos Corp., Hagerstown, Md., has purchased the Hiller Aircraft Co., a division of ELTRA Corp. Hiller, located in Palo Alto, Calif., will operate as a wholly-owned subsidiary of Fairchild. . . . *Universal Oil Products Co., Des Plaines, Ill., has acquired Aerotec Industries, Inc., Greenwich, Conn., for a cash settlement of more than $5 million. Aerotec manufactures specialized equipment for missile/space, aircraft and nuclear systems and industrial air pollution control equipment.* . . . Norris-Thermador Corp., Los Angeles, has completed negotiations for the purchase of Hesse-Eastern, Inc., Everett, Mass. H-E has been conducting R&D work on ammunition, fuses and infantry weapon systems, including the Light Anti-tank Weapon (LAW).

New Activities

Air Reduction Company, Inc., New York City, has formed an Aerospace Systems Group in Jersey City, N.J., to handle Government inquiries requiring the development of engineering data and the preparation of proposals for missile/space and aircraft projects. The new group will function under the Cryogenics Engineering Dept. of AR's Sales Co. Div. . . . *Westinghouse Electric Corp.'s Scientific Equipment Dept. has formed a new Vacuum Systems Design Group initially to operate in its molecular electronics plant in Newbury Park, Calif. The new group will design and manufacture vacuum systems and accessories.* . . . CTS Corp., Elkhart, Ind., has organized a wholly owned subsidiary, CTS Microelectronics, Inc., in Ridgefield, Conn. The new subsidiary is the fourth CTS facility to produce microelectronics components and circuits. . . . *The Minnesota Mining and Manufacturing Co., St. Paul, Minn., has established a special coordinating committee and office in Washington, D.C. Primary function of the activities will be to maintain contact with the Atomic Energy Commission regarding SNAP projects.*

New Facilities

Aluminum Co. of America is planning additions to both smelting and fabricating facilities at its Warrick, Ind., Works. The firm's second 35,000-ton potline will be installed and in operation by next spring. An aluminum hot rolling mill is scheduled for completion at the same time. . . . *RCA Electronic Components and Devices has moved its sales office from Burlingame, Calif., to 4546 El Camino Real, Los Altos, Calif.* . . . Bendix Corp.'s Southern California sales offices for its Scintilla Div. have been relocated at 1001 S. Grand Ave., Santa Ana, Calif. The offices were formerly in San Diego and Burbank. . . . *Union Carbide Corp. has started an expansion program at its Stellite Div. wrought alloy production facilities in Kokomo, Ind. A cold-rolling mill will be the major item in the program. Completion is scheduled for fall, 1965.* . . . Micro-Vu Corp., Burbank, Calif., has moved into a new 10,000-sq.-ft. plant in Burbank. The company produces portable optical comparators. . . . *Vac-Hyd Processing Corp., Detroit, Mich., has established a new metal fabricating service which employs a method of high energy discharge called the electrohydraulic effect.* . . . The Minnesota Mining and Manufacturing Co.'s Mincom Div. has consolidated all its Los Angeles facilities in the new Mincom Building in Camarillo, Calif.

International

Raytheon Co. and Hawker de Haviland Australia Pty., Ltd., Lidcomb, N.S.W., have reached an agreement whereby Hawker de Haviland will serve as Australian representative for Raytheon in the areas of lasers, communications equipment, tubes, microwave ovens and mechanical components and hardware. . . . *General Precision Equipment Corp., Tarrytown, N.Y., and The Decca Navigator Co., Ltd., London, have jointly formed General Precision Decca Systems, Inc., to design, produce and market electronic navigation equipment for commercial and military aerospace applications and military marine requirements. Products will include hyperbolic navigation systems, position fixing systems for survey, airborne computers and pictorial displays.* . . . Westinghouse Electric International has formed a new subsidiary, Westinghouse International Defense and Space Corp. with headquarters in New York City. The new corporation will work with the Westinghouse Defense and Space Center in Baltimore and the Aerospace Electrical Div. in Lima, Ohio, and will serve as a consolidation point in foreign countries for providing the company's defense and space products and services. . . . *Garrett Manufacturing Ltd., Toronto, a subsidiary of the Garrett Corp., has completed arrangements with the Canadian government to perform an R&D program to design a family of static inverters incorporating solid-state electronics.*

advertising closes may 20 published june 1





M/R



special report:

electro-optical systems

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range instrumentation
scientific or research instrumentation
lasers
guidance and navigation
surveillance and reconnaissance
solar power conversion
metrology

missiles and rockets



AWARDS

AIR FORCE

$20,600,000—**The Boeing Co.,** Seattle, for production of *Minuteman* ICBM's.

$2,500,000—**Mitre Corp.,** Bedford Mass. for continued work on command and control systems.

$2,400,000—**North American Aviation Inc.,** Anaheim, Calif., for spare parts for *Minuteman* missile guidance and control systems.

$1,700,000—**IBM Corp.,** Owego, N.Y., for computer system maintenance.

$1,400,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for further work on space programs.

$1,100,000—**Sperry Rand Corp.,** Sperry Gyroscope Div., Great Neck, N.Y., for work on radar components.

$511,961—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., for a study of performance characteristics of compound "A" hydrazine propellant combination.

$100,000—**Products Research Co.,** Burbank, Calif., for chemical protective coatings to prevent damage to launching silos from heat and blast resulting from missile firings at Vandenberg AFB, Calif.

$75,251—**Martin Marietta Corp.,** Denver, for a study and experimental research on air-augmented rocket propulsion.

$68,000—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., for a study to provide analytical design data on rocket propulsion system seats and poppets.

$63,689—**Aerojet-General Corp.,** Azusa, Calif., for a study of a pentaborane-hydrazine reaction.

$55,757—**Bendix Corp.,** Friez Instrument Div., Baltimore, for redesign and fabrication of AN/DMQ-9 rocketsondes.

$49,211—**Thiokol Chemical Corp.,** Elkton, Md., for investigations of broad-spectrum volumetric response in solid propellants.

$48,717—**Martin Marietta Corp.,** Baltimore, for research in theoretical and quantum chemistry of boron compounds.

$40,559—**General Dynamics Corp.,** Astronautics Div., San Diego, Calif., for investigation of automatic methods of meteorological satellite data analysis.

Telecomputing Corp., Whittaker Controls and Guidance Div., Los Angeles, for delivery of a Miniature Attitude Reference System (MARS) for use in a classified Air Force program (amount undisclosed).

ARMY

$11,900,000—**General Dynamics,** Pomona Div., Pomona, Calif., for further work on the *Mauler* missile system.

$5,600,000—**H. R. B. Singer, Inc.,** State College, Pa., for surveillance systems.

$3,500,000—**Raytheon Co.,** North Dighton, Mass., for follow-on production of modification kits for radar systems.

$3,500,000—**Raytheon Co.,** Lexington, Mass., for further work on the *Hawk* missile system.

$2,600,000—**Raytheon Co.,** Lexington, Mass., for radar equipment modifications.

$1,500,000—**Filtron Co.,** Flushing, N.Y., for work on classified electronics.

$1,200,000—**Fruehauf Corp.,** Fullerton, Calif., for ground support vehicles related to the *Sergeant* missile system.

$368,875—**Aerojet-General Corp.,** Downey, Calif., for follow-on funding related to completing development of the XM-484.

$255,300—**Sperry Rand Corp.,** Sperry Utah Co., Salt Lake City, Utah, four contracts for repair parts related to the *Sergeant* missile system.

$52,023—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for sounding rocket data-processing study and scope of work continuity related to the *Nike Yard-Bird* missile.

ITT Federal Laboratories, San Fernando, Calif., two contracts for studies and work on image integrating and microminiature wafer image intensifiers (amount undisclosed).

NAVY

$9,000,000—**Beech Aircraft Corp.,** Wichita, Kan., for production of an additional quantity of AQM-37A (KD2B-1) rocket-powered supersonic missile targets.

$1,400,000—**Interstate Electronics Corp.,** Anaheim, Calif., for work on the *Polaris* Operational Readiness Instrumentation program.

$1,300,000—**Minnesota Mining and Manufacturing Co.,** St. Paul, Minn., for R&D on high-energy oxidizers.

$166,000—**Data Display, Inc.,** St. Paul, Minn., for provision of a data display system to simulate, study and experiment with man-to-machine communications.

NASA

$1,100,000—**ITT General Controls, Inc.,** Warwick, R.I., for *Saturn V* test facility components.

$1,000,000—**Cyclops, Inc.,** for provision of cranes and hoists for the Moon base building at Cape Kennedy.

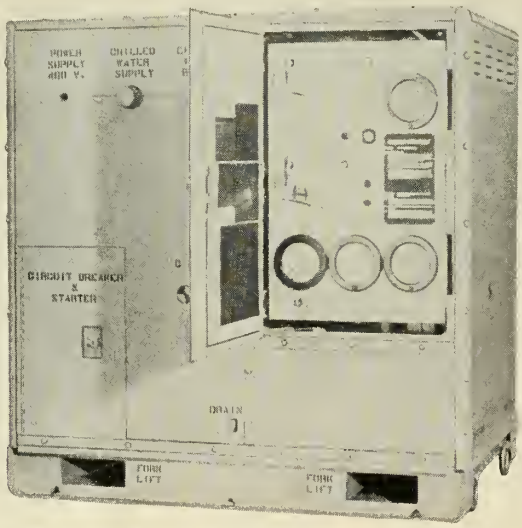
$263,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for a rocket study of stellar X-ray emissions.

$98,112—**Textron Electronics, Inc.,** New Haven, Conn., for a random-sine vibration and equalization system.

$92,085—**Bolt, Beranek and Newman, Inc.,** Cambridge, Mass., for design, development and prototype delivery of a three-axis attitude display system for spacecraft.

$69,700—**Prengle, Dukler & Crump, Inc.,** Houston, for a study of chemical explosions in space.

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$64,440—**Douglas Aircraft Co.**, Missiles & Space Systems Div., Santa Monica, Calif., for research on improved methods of celestial mechanics.

$50,760—**Digital Equipment Corp.**, Maynard, Mass., for a processor and digital controller.

$46,354—**Miller & Berry, Inc.**, for an encapsulation laboratory at Marshall Space Flight Center.

$40,000—**Emerson Electric**, St. Louis, for development of char progression sensors.

$37,500—**Bio Technology, Inc.**, Arlington, Va., for development of tests for measurement of primary perceptual motors.

$26,702—**Hewlett Packard Co.**, Dymec Div., Palo Alto, Calif., for parts related to scanner converters, voltmeter and digital clock.

Block Engineering, Inc., Cambridge, Mass., for the design and construction of three instruments to be used in optical experiments conducted during the fifth *Gemini* flight (amount undisclosed).

General Electric Co., Missile & Space Div., Valley Forge, Pa., for a study to determine the magnitude and direction of thermal bending of gravity gradient rods (amount undisclosed).

INDUSTRY

$2,782,000—**Farrand Optical Co.**, Bronx, N.Y., from **Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for design, development and production of two external visual displays to be used in simulation work for the Lunar Excursion Module.

$300,000—**Philco Corp.**, TechRep Div., Philadelphia, from **Massachusetts Institute of Technology**, Lincoln Laboratory, Cambridge, Mass., for data-processing services for one year in support of Project PRESS, an investigation of the physical effects associated with flight of ballistic missiles from mid-course through re-entry.

$270,575—**Burroughs Corp.**, Detroit, from the **Atomic Energy Commission** for a B283 electronic computer system.

$250,000—**IBM Corp.**, New York City, from **The Boeing Co.**, AeroSpace Div., Huntsville, Ala., for provision and installation of an IBM 7094 computer for spaceflight simulation at the Boeing simulation center in Huntsville.

$131,000—**Technical Construction Co.**, Compton, Calif., from **Air Reduction Pacific Co.**, for construction of a liquid nitrogen facility at Los Angeles' City of Industry plant.

$130,000—**Informatics, Inc.**, Culver City, Calif., from **Sperry Rand Corp.**, Univac Div., New York City, for provision of operational programs for the 418 computer.

Thermatest Laboratories, Inc., Sunnyvale, Calif., from **North American Aviation, Inc.**, Space and Information Systems Div., Downey, Calif., for development and production of *Apollo* heat-shield instrumentation and electronics (amount being negotiated).

Mechanics Research, Inc., El Segundo, Calif., from **Jet Propulsion Laboratory**, Pasadena, Calif., for a research study to develop lightweight dampers for spacecraft (amount undisclosed).

Argus, Inc., Argus Optics Div., Ann Arbor, Mich., from **Chicago Aerial Industries, Inc.**, Chicago for production of precision optical components for an aerial reconnaissance viewfinder (amount undisclosed).

Microdot, Inc., South Pasadena, Calif., from **Ling-Temco-Vought, Inc.**, Dallas, for operational UHF telemetry transmitters for the Air Force's *Low Altitude Supersonic Vehicle* program (amount undisclosed).

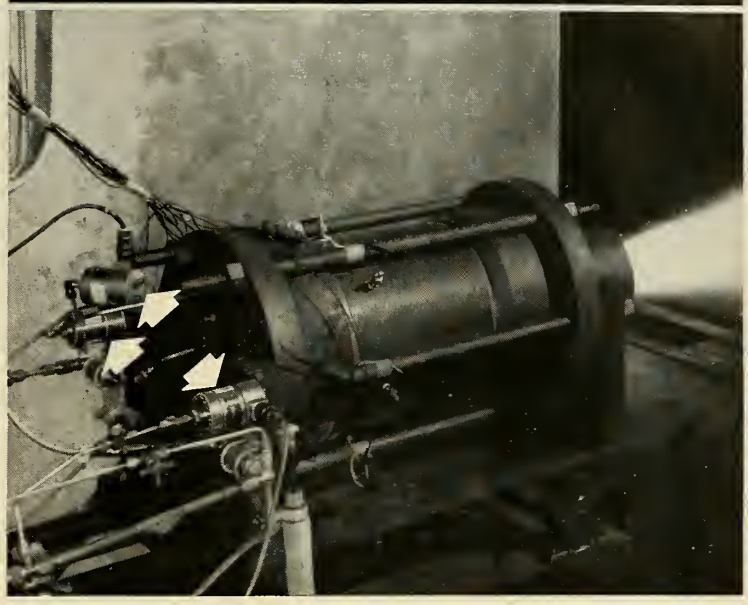
ATOMIC ENERGY COMMISSION

$270,575—**Burroughs Corp.**, Detroit, Mich., for a B283 electronic computer system.

U.S. ARMS CONTROL AND DISARMAMENT AGENCY

$107,000—**Battelle Memorial Institute**, Columbus, Ohio, for a research study of the implications of reduced defense demand for the electronics industry.

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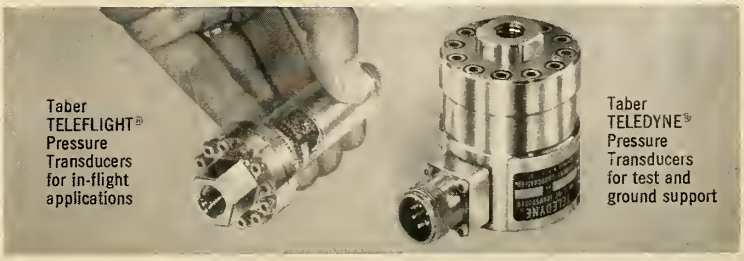
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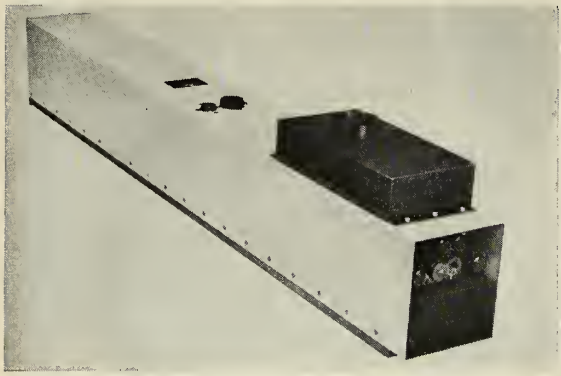
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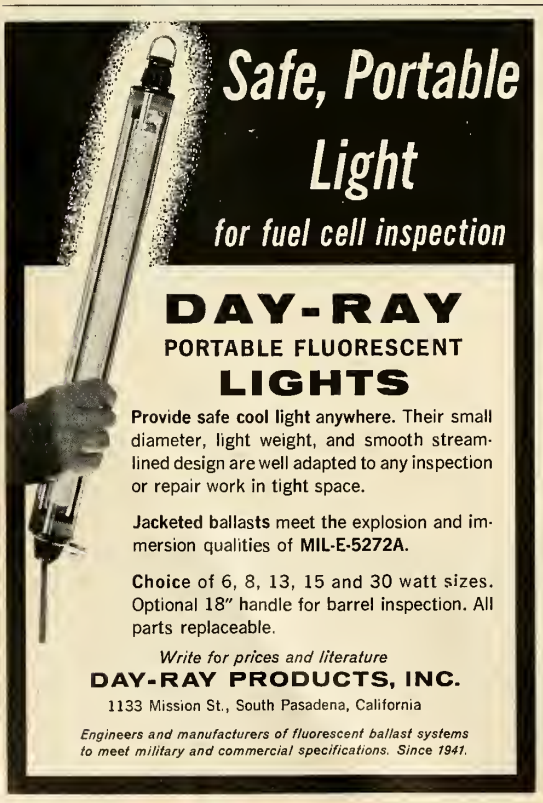
New Product of the Week: Helium-Neon Laser

Raytheon Co.'s Laser Advanced Development Center has developed a continuous wave helium-neon gas laser with a 100-milliwatt minimum output.

The Model LG-10 uses two plasma discharge tubes optically coupled through a prism to produce a single laser beam directed from one tube into a second parallel one. The tubes employ direct current for simpler operation.

The unit is 57 in. long, weighs less than 50 lbs., and is capable of withstanding shocks up to 10 g's. Designed for output at 6,328 Angstroms, the device can produce coherent light at 1.15 or 3.39 microns with minor modifications.

Circle No. 151 on Subscriber Service Card



Circle No. 5 on Subscriber Service Card

Vacuum Pumping System

Linde Div. of Union Carbide Corp. is marketing the SN-12 cryosorption vacuum pump. Based on the principle of gas adsorption at cryogenic temperatures, the pump has no moving parts or working fluids, thus eliminating the danger of contamination from back-streaming of oil.

The unit can evacuate volumes up to 20 cu. ft. It consists essentially of an adsorption chamber packed with molecular sieves which can be sealed in a liquid nitrogen reservoir. Vacuums as low as 10^{-6} or 10^{-7} torr can be produced by operating two more units in stages.

The unit is made ready for operation by filling the reservoir with liquid nitrogen, which precools the adsorbent to around —320°F in 10 to 20 minutes. Pump-down begins as soon as the vacuum valve is opened in the pipeline. Performance is improved if the space to be evacuated is first purged with dry nitrogen gas to eliminate uncondensable gases.

Circle No. 152 on Subscriber Service Card

Oscillator-Preselector

A tunable oscillator-preselector available in 14 octave ranges from 50 to 750 mc has been announced by Telonic Engineering Co.

The device combines a three-section tunable band-pass preselector with a solid-state local oscillator to provide an output of 10 mw, minimum. Fourteen models are available, each covering one frequency octave with 100% overlap. The units are equipped with a vernier-type tuning dial and type N connectors.

Circle No. 153 on Subscriber Service Card

Torque Meter

Power Instruments, Inc., is marketing the Model 784 Torqmeter for measurement of torque of motors, pumps, reducers, actuators and oscillating mechanisms at speeds from 0 to 4,000 rpm.

In the device, a hardened-steel torsion element is keyed to opposed, hollow, interlocked shafts. A differential gear set between shafts senses a change in phase when they are torsionally deflected and transmits the motion to a gage movement calibrated in lb.-in. The differential carries no torque. Full-scale reading is obtained at four degrees torsional deflection.

Six interchangeable torque elements are provided with full scale values at 5, 10, 20, 50, 100 and 200 lb.-in. Accuracy is 2% at static and slow speeds, 3% over 1,800 rpm.

Circle No. 154 on Subscriber Service Card

Germanium Single Crystal

A specially doped germanium single crystal, used in lithium-drift nuclear-particle detectors, is available from Sylvania Electric Products, Inc.

The P-type, gallium-doped crystal is being offered in two different trapezoidal cross-sections. One weighs 63 grams per linear inch; the other, 120 grams per linear inch.

Circle No. 155 on Subscriber Service Card

Precision Volt Box

A precision volt box designed to extend the range of laboratory potentiometers up to 1,500v is being marketed by Honeywell's Denver Div.

The Model 2851 has input working taps of 3, 7.5, 15, 30, 75, 150, 300, 750 and 1,500v. Input guard taps are

15v and above. Guaranteed limit of error is ±0.005%. Calibrated accuracy is ±0.002%.

The unit is thermally and electrostatically shielded and available for rack or bench use.

Circle No. 156 on Subscriber Service Card

TTL Gates

Two transistor-transistor logic (TTL) gates, originally developed for an airborne computer system, are being offered in sample quantities by Lansdale Div. of Philco Corp.

The microelectronic units are available as a dual four-input gate and a single eight-input gate, both designed for a fan-out of 15. The gates come in flat packages, ¼ x ⅜ in. Typical propagation delay times are 25 nanosecs with zero-load capacitance and 60 nanosecs with a 600-pf load. Noise immunity ranges from more than a volt at room temperature to a minimum of 300 mv at 125°C.

The gates are primarily intended for applications where high noise pulses are encountered or where large stray load capacitances must be driven.

Circle No. 157 on Subscriber Service Card

Cavity Oscillator

Sanders Associates, Inc., has announced a miniature solid-state cavity oscillator for VHF, UHF and microwave applications.

The device is stable to one part in 100,000 per degree C over a range of —54° to 90°C. It occupies less than 2.5 cu. in. and operates on 28v dc power input. Tuning over a 10% band is done by a mechanical "set screw" adjustment. Optional varactor voltage tuning is available with a 50-mc range resulting from a 60v change in tuning input.

The Model DG504, operating at 1 gc with 20 milliwatt output power, is presently available. Other models ranging from 250 mc at 60 milliwatts to 1.2 gc at 6 milliwatts will be available in the near future. All models meet MIL-1-6181D requirements.

Circle No. 158 on Subscriber Service Card

Gas Tube Power Supply

A gas tube power that fires and maintains noise sources automatically is being manufactured by Microwave Components & Systems Corp.

In operation, the firing circuit automatically initiates repetitive high-voltage ionizing pulses until the gas tube fires. Upon firing, the pulses cease and the power supply maintains proper operating current through the tube.

Operating range is 40 to 200 milliamps in two models. Input power is 110v, 60 cps, 1-phase, 90 watts. Heater supply is 6.3v ac at 2 amps. The ionizing pulses are cathode terminal negative going 2,500v with respect to anode terminal. Output terminal connections are floating and may be grounded as desired.

Circle No. 159 on Subscriber Service Card

Power Inverters

Linear Systems, Inc., has available the Model 12-500S power inverter, intended for application to problems involving the operation of ac equipment from storage battery power.

The unit has a frequency stability of ±0.5 cps over a 22 to 15-v dc input range and/or the load range to 500 watts taken compositely. Operating temperature range is —25° to 60°C. Output frequency is adjustable for a minimum of ±5 cps.

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REFRACTORY METALS APPLICATION NOTES

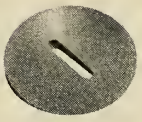
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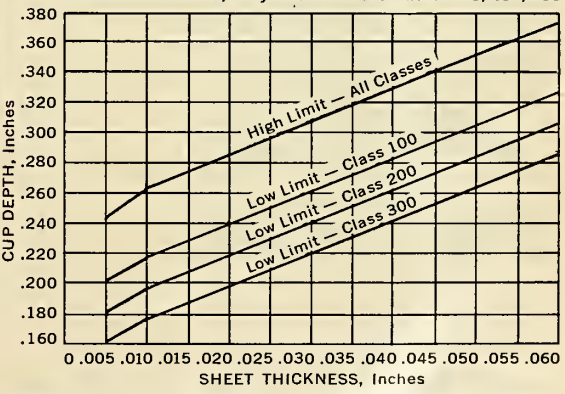


CLASS 200 General purpose moly sheet with specified reproducible mechanical properties. Use it for less demanding applications where the more highly defined mechanical properties of Class 100 are not needed. Available in widths from ⅛″ through 24″.



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*Olsen Cup Test—a cupping test in which a metal sheet, restrained except at the center, is deformed by a standard steel ball until fracture occurs. The height of the cup upon fracture is a measure of ductility.



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names in the news


LEVY


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GREENWOOD

Marvin J. Levy: Appointed general manager, military systems area, for Belock Instrument Corp., College Point, N.Y.

Roger Reynolds, Jr.: Named divisional vice president, electronic tube division, at General Atronic Corp., Philadelphia.

Eugene J. Moscaret: Named vice president-marketing at Consolidated Electrodynamics Corp., Pasadena, Calif.

Robert C. Loomis: President of American Electronics, Inc., Fullerton, Calif., elected chairman of the board. **Gerald E. Donovan,** a director, named vice chairman of the board, and **Fred A. Simpson,** secretary-treasurer, named a vice president.

Stewart Pfannstiehl: Elected president of Oak Manufacturing Co., Crystal Lake, Ill.

Gilbert A. Peters: Appointed manager of Radio Corp. of America's Data Systems Center, Bethesda, Md.

T. William Benedict: Promoted to director of marketing for the Singer Co.'s Metrics Div., Bridgeport, Conn.

James R. Greenwood: Appointed corporate director of public relations for the Lear Jet Corp., Wichita, Kan.

James H. Smith: Appointed manager-standard product sales for Dynatronics, Inc., Orlando, Fla.

William Seiden: Appointed acting general manager of Packard Bell Electronics Corp.'s computer division, Los Angeles.

Robert E. LaCroix: Named manager of the applied physics department of the Westinghouse Research Laboratories, Pittsburgh.

E. Dana Gibson: Appointed general manager of Shawnee Industries, Inc., Shawnee, Okla.

Jack Golden: Appointed director of the Program Management Div. of Mesa Scientific Corp., Inglewood, Calif.

David L. Bell: Appointed manager of government marketing of P. R. Mallory & Co., Inc., Indianapolis, Ind.

Paul Tbayer: Promoted to executive vice president-aerospace group at Ling Temco-Vought, Inc., Dallas.

Samuel G. Harris: Appointed director of marketing at Delta Electronics, Inc., Alexandria, Va.

Raymond C. Kopituk: Appointed vice president of Coast Metals, Inc., Little Ferry, N.J.

H. M. Johnson: Appointed manager special projects-marketing for the Silicones Div. of Union Carbide Corp., New York City. **Milton L. Dunham** appointed product manager-functional fluids, and **Norman E. Stuessy** appointed assistant eastern regional manager.

Ludwig P. Reiche: Appointed manager communications systems for Stellarmetrics Inc., Santa Barbara, Calif.

Milton G. Hulme, Jr., and Dr. Elmer S. McKee: Elected vice presidents of Catalyst Research Corp., Baltimore.

Ernest G. Khougaz: Promoted to western regional manager of Korad Corp. Santa Monica, Calif.

Roland Saye: Appointed deputy director of *Saturn* programs at the Douglas Aircraft Co.'s Missile & Space Systems Div., Santa Monica, Calif.

A. F. Rense: Named manager of public relations for the Douglas Aircraft Co.'s Missile & Space Systems Div., Santa Monica, Calif.

Dr. Roberto Vaglio-Laurin: Named head of the Aerospace Research Institute of the Polytechnic Institute of Brooklyn, N.Y.

Raymond A. Wilhite: Appointed a district sales manager for Motorola Semiconductor Products, Inc., Fullerton, Calif.

G. Larry Wolf: Joined R.I.C. Products Corp., Detroit, Mich., as sales engineering representative for Western Ohio, Southern Indiana and Kentucky.

Howard M. Kindsvater: Named principal engineer and assistant manager of propulsion engineering at Lockheed Missiles and Space Co.'s research and development division, Sunnyvale, Calif.

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16th Annual National Aerospace Electronics Conference (NAECON), IEEE and Dayton Section of the AIAA, Biltmore Hotel, Dayton, Ohio, May 11-14.

Symposium on Applied Mathematics and Mechanics in Honor of Theodore von Karman, sponsored by AF Office of Scientific Research and the Society for Industrial and Applied Mathematics, Shoreham Hotel, Washington, D.C., May 11-14.

35th Annual Scientific Meeting, Aerospace Medical Association, Americana Hotel, Bal Harbour, Miami Beach, Fla., May 11-14.

ASME Design Engineering Conference, McCormick Place, Chicago, May 11-14.

U.S. Army Electronics Research and Development Laboratory, Symposium on Hydrogen Thyratrons and Modulators, Fort Monmouth, N.J., May 12-14.

Plastics and Adhesives in the Space Age, Regional Technical Conference, Society of Plastics Engineers, Garden City Hotel, Garden City, N.Y., May 13-14.

Society of Technical Writers and Publishers Conference, El Cortez Hotel, San Diego, Calif., May 14-16.

ASME Fluids Engineering Conference, Bellevue-Stratford Hotel, Philadelphia, May 19-21.

IEEE International Symposium on Microwave Theory and Techniques, Kennedy International Airport, New York, May 19-21.

Armed Forces Communications and Electronics Association Annual Convention and Exhibit, Sheraton-Park Hotel, Washington, D.C., May 19-21.

Space and Defense Procurement Briefing Conference, sponsored by Federal Bar Association and Bureau of National Affairs, Sheraton Hotel, Houston, May 20-21.

Seventh National Symposium, "Adhesives and Elastomers for Environmental Extremes," Society of Aerospace Material and Process Engineers, Thunderbird Motel, El Segundo, Calif., May 20-22.

First Annual Symposium of the Subcommittee on Research and Development Contracts, Committee on Government Contracts and Procurement, Federal Bar Association, Waldorf-Astoria Hotel, New York City, May 25.

Aviation/Space Writers Association Annual Conference and News Meeting, Americana Hotel, Bal Harbour, Miami Beach, Fla., May 25-29.

International Electrical Industry Sbow, New York Coliseum, New York City, May 25-27.



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Praise for Caesar

AFTER FIVE DAYS of perfunctory hearings, the House investigation into the *Ranger* program has been closed. Although one would hesitate to call it a whitewash, the probe certainly left many questions unanswered—including a number raised during the hearings.

One cannot lay the blame for this at the door of the able chairman of the House subcommittee on NASA oversight, Joseph Karth (D-Minn.) To observers, it seemed that his hands were tied by what appeared to be almost a conspiracy to soothe the wounded feelings of Jet Propulsion Laboratory.

Some answers to committee questions were evasive and there were some flat refusals to answer. To his credit, this did not pull the wool over the eyes of the subcommittee chairman. Rep. Karth puts it this way:

"I think I learn more from what people refuse to say than what they say. I choose not to abuse witnesses—which you can, you know. But sometimes with evasive answers, you can evaluate them better than if you make (the witness) say yes or no, since he may not be at liberty to give a direct answer."

There were a number of surprising developments before and during the hearings. One was the letter from National Aeronautics and Space Administrator James Webb to the chairmen of the Senate and House space committees, sharply critical of JPL's management of the *Ranger* program. In that letter, Mr. Webb stated:

"Detailed analysis of the *Ranger VI* flight and the associated procedures and tests indicate there were a number of deficiencies in design, in construction and in the testing of this spacecraft."

Yet this was followed by a letter from NASA, received by the committee just prior to opening of the hearings, which called them unfortunate and which was an obvious attempt to head off or restrict the investigation.

This was NASA Administrator Webb's position as stated in that later letter to Rep. Karth:

"I hope you will keep in mind that the timing of these subcommittee hearings is unfortunate in that the factors of morale and program execution are both deeply involved, and there are very real dangers that both may be seriously affected."

This smacked of the Pentagon's attempt to close off the McClellan committee investigation of the TFX aircraft for similar reasons. As a matter of fact, there was some considerable suspicion that the House subcommittee action was intended to head off more penetrating action by the McClellan committee itself.

House Space Committee chairman George Miller (D-Calif.) did nothing to allay this suspicion when he said he wanted his committee to look into the *Ranger* situation "before any other committee picked it up."

As a matter of fact, Rep. Miller's position in the probe was a very strange one. This was his comment:

"I hope you have allayed any fears of the JPL people that we are being critical of them. We are not being critical of anyone. We are trying to explore problems around *Ranger* so that we can answer the critics of NASA and the program that will be sure to arise if we have another not entirely successful flight."

Just why Rep. Miller should choose to cast his committee as a defender of NASA against its critics is not quite clear. We have always been under the impression that it was one of the duties of Congress to probe into mismanagement or inefficiencies in the Executive Branch and to be as critical as seemed necessary. Thus, we find it very odd that a committee chairman should require his committee to "answer the critics of NASA."

The question of whether the investigation was ever intended to be a penetrating one certainly is raised by Rep. Miller's further comment:

"Personally, I think that JPL is to be congratulated upon the work that it has done in *Mariner* and *Ranger*. Because the camera failed and the pictures didn't come back, some may look upon this as a failure. This to me is the secondary part. The fact that you were able to hit the Moon at the place you aimed for is a tremendously big achievement. I think the last *Ranger* flight could be called a success for this reason."

When one considers that this comment is made concerning a program costing $248 million for six successive failures, one is forced to wonder about Rep. Miller's objectivity in the investigation.

THE INVESTIGATIVE SUBCOMMITTEE will confine itself in its report to managerial problems in the program and not delve into technical competence. How the two can be easily separated is a mystery to us. We also wonder how this can be squared with Mr. Webb's original statement about deficiencies in design, construction and testing. There obviously are many professionally competent technical people at JPL. We know a number of them. There also obviously are some incompetents, and for anyone to suggest otherwise is to suggest that JPL must have management of a caliber unmatched anywhere in the industry.

The House probe also stopped short of delving into personality clashes in the NASA-JPL-Cal Tech relationship, yet it was evident that there was much more to these than showed.

Rep. Karth says: "We must conclude that yes, there was the possibility of strong personality clashes which I hope will be resolved if and where they exist. It is not important for me to know where they exist, but if. The report will deal with this, and we will watch it closely. We will give those involved strong encouragement to bury the hatchet."

The hearings left unanswered the question of why NASA permitted for two years JPL's continued refusal to put *Ranger* on a project basis. The space agency obviously fell down in its direction of JPL—and poor management there was compounded by poor management at NASA.

William J. Coughlin

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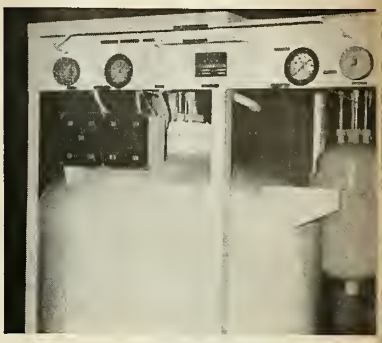
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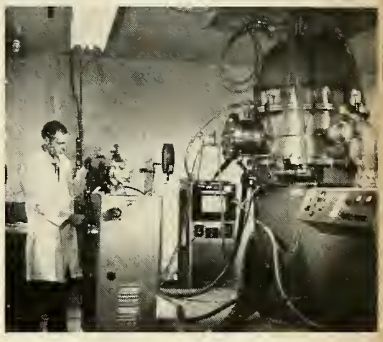
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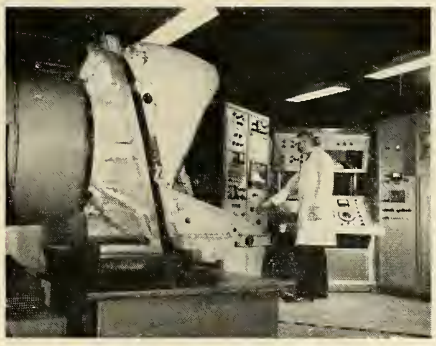
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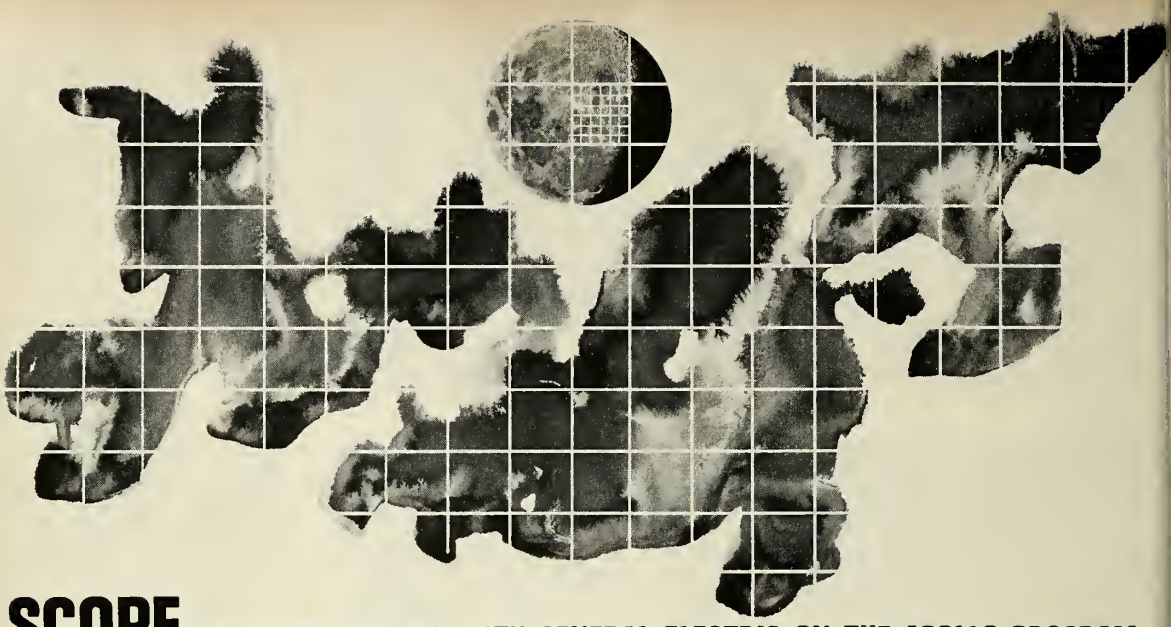
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THE COVER



U.S. Army soldier lifts Shillelagh antitank and field fortification missile under development by Philco's Aeronutronic Div. The weapon will be carried by the Sheridan tracked vehicle, and is being developed for Army Weapons Command, Rock Island, Ill. Shillelagh is the first guided missile to be fired from a gun that also fires conventional ammunition.

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letters

Retaliatory Mix

To the Editor:

Regarding the present discussion of the proper mix between ballistic missiles and manned aircraft (if Mr. McNamara is going to allow any mix), it seems to me that one very important point has not been emphasized strongly enough, in your publication or anywhere else. That point is that missiles cannot "see" where they are going—whoever shoots them must know exactly where the target is. Otherwise he might just as well be throwing a brick. Now, if our retaliatory response is to be limited solely to blasting the enemy's cities, we undoubtedly have sufficient target information. Of course, this is a rather inflexible response.

If, on the other hand, we wish to pick and choose our targets, including specific enemy launch sites, command posts, communications centers, etc., then we darn well better know precisely where they are. (If they happen to be mobile, this poses a pretty problem.)

Is our intelligence information all that good? Past performance leaves some doubt.

J. F. Newton
East Amherst, N.Y.

Academic Pressures

To the Editor:

I commend your March 23 editorial, "Alma Maters or Madams?"

A similar case happened in Illinois to one of my colleagues. He was ordered to write a proposal for a government-sponsored project against his wishes and protests—there were no qualified available assistants nor office space for them. The sponsoring government agency sent the contract to the university during the summer, when he was abroad. Another staff member signed the contract in his name as project supervisor because of pressure from superiors. When my colleague returned to campus in the fall, his department head notified him that he was solely responsible for completion of the project, without any assistant help, although the contract provided for two assistants. The matter was referred to the Dean, who called my friend and shouted—these days some deans do not talk to professors, they shout—that he had to work on the project alone since he alone had undertaken it.

It seems that governmental institutions should take a closer look at the way in which some universities fulfill their obligations.

(Name and address withheld on request)

Defense Needs

To the Editor:

Your May 4 editorial ("The Day He Dies") reflects an extremely narrow viewpoint in the present world situation. You usually consider all aspects of any problem; as a result, your editorials are extremely stimulating. I strongly urge you to read Roswell L. Gilpatric's article entitled "Our Defense Needs: The Long View" in the April issue of *Foreign Affairs*.

S. N. Graybeal
Bethesda, Md.

To the Editor:

I have been disappointed in your two recent editorials "Hogwash in Harper's" (March 16) and "The Day He Dies" (May 4) in which you pooh-pooh the sincere attempts to awaken the industry and the nation to the real problems of the economic conversion of the aerospace industry. I feel that you would be doing everyone a service if you would get with it—instead of fighting the inevitable—and open your magazine to enlightening your readers as to the issues in the expanding great debate. I think you could help the cause if you pointed out that conversion is important, not just as an alternative to disarmament but as a necessary goal brought about through automation and changes in technology.

Donald W. Cox
Philadelphia

Better Cost/Effectiveness

To the Editor:

In several of the trade journals (including M/R) there are appearing articles referring to the cost/effectiveness of weapon systems. In each case, there is reference to trying to seek higher cost/effectiveness ratios. It is understood by most people in the Defense community that what is being sought is increased performance and effectiveness for the dollar investment. But technically speaking, this ratio should be expressed as seeking higher effectiveness/cost ratios or lower cost/effectiveness ratios. Obviously, by using the most basic rudiments of mathematics, this is the correct definition. Whoever started this fiction apparently wasn't exercising prudent analytical terminology.

E. L. King
Rochester, N.Y.

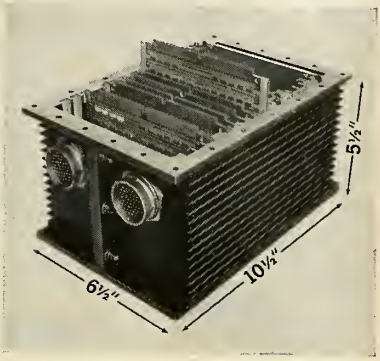
Dynasil Lenses

To the Editor:

In your Technical Countdown item "Corning Supplies Solar Simulator Optics" (M/R, May 4, p. 21), we wish to point out that you omitted to mention that, for each module, one of the four fused silica lenses used for the simulator by NASA's Goddard Space Flight Center was Dynasil Synthetic Fused Silica, manufactured by the Dynasil Corporation.

Martin Saepoff
Dynasil Corp. of America
Berlin, N.J.

And is this what most engineers mean when they say APPLIED MICROELECTRONICS?



It is called the D26J computer.

Actually, the D26J is part of the MONICA family of microelectronic computers designed and put in production by the Autonetics Division of North American Aviation.

The MONICA family of data processors has a reliability of thousands of hours of failure-free operations and a capacity far greater than the famed Autonetics VERDAN computer. With the same careful design engineering that produced the VERDAN and MINUTEMAN computers, MONICAs are for advanced military applications.

A central data processing member—the D26C—of the MONICA family has a random access, magnetic core memory which retains 8,192 words (expandable to 32,768 words) and a rapid access memory of 256 words, one microsecond cycle time. Its 30-bit word format provides the precision required for most applications without requiring double precision subroutines.

A minimal guidance machine, the D26J is .15 cubic feet and weighs just 13 pounds. The central data processing D26C is .65 cubic feet and weighs 40 pounds.

The MONICA family of computers is designed to combine high reliability and large capacity with building block flexibility. Their ease of maintainability assures total cost effectiveness.

A related microelectronic computer is the D37B. Its rotating disk memory and 6,966 word capacity of 24 bits, already has been tested and is in production for use in the WS-133B or MINUTEMAN II weapon system.

This is but one more example of how the engineers and scientists at Autonetics are forging ahead in the field of applied microelectronics and total systems integration... another reason Autonetics is setting standards for the entire electronics industry.

North American Aviation Autonetics

THE WINDOW IN THE OCEAN HAS GROWING PANES



That window of knowledge in the ocean is getting bigger all the time. At Vitro, teams of scientists are involved in oceanography, both under Navy contract and in-house R&D. They are performing basic studies into the science of the sea, designing instruments for deep submergence, and analyzing and cataloging oceanographic data. It was a background in acoustics, instrumentation and operations research that helped qualify Vitro for the Navy ASWEPS program.

Among many specific Vitro accomplishments are: operations analyses applied to ocean environment . . . datum buoys for airborne ASW . . . velocimeters . . . wire coils and miniature coax for weapons guidance, underwater communications and telemetry . . . underwater vehicles . . . and underwater range operations.

Despite complexity of the problems, real progress is being made in the study of this environment. For more information on Vitro capabilities in oceanography, contact Owen E. Cunningham, Vitro Laboratories, 14000 Georgia Avenue, Silver Spring, Maryland, (301) 942-7200.

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The Countdown

WASHINGTON

Congress Denies Pluto Reactor Bid

A $1.5-million cut in the Atomic Energy Commission's request for the Pluto program reflects the conviction of the (Congressional) Joint Committee on Atomic Energy that the next step in the program should be a flight test—not an advanced reactor. "Any make-work activity in this program cannot be justified," they say, and AEC and DOD should "quickly" prepare plans for a flight. If the committee is presented with a flight-test program, it will reconsider the follow-on proposal.

A Mission for the 156-incher

One assignment being considered for the 156-in.-dia. large solid booster is to carry the 100-megaton warhead—if the U.S. ever decides such a weapon is required. The big solid would form the first stage of the missile and a highly advanced liquid engine the second stage. A two-stage missile of this type might also carry extremely large payloads of penetration aids and multiple warheads.

How NASA Will Spend Unrequested Money

The $4 million Congress gratuitously gave NASA for advanced propulsion work will allow the agency to look at a number of new possibilities, including all the amines and select hydrocarbons, says A. O. Tischler, director of propulsion in the Office of Advanced Research and Technology. He says there also will be heavy concentration on materials technology and cooling techniques.

Single System for Sergeant/Pershing

A follow-on to the Army's solid-fueled *Pershing* and *Sergeant* missiles is most likely to be a single system covering the range spectra of both weapons. Guidance and propulsion systems would be modular, so that the missile could be tailored to the range required.

Minuteman Shots Carrying Star Trackers

Several *Minuteman* R&D shots are reported to have borne star trackers to assess their performance. This could be part of the AF study of a two-stage *Minuteman* substitute for *MMRBM*. More likely, it may be an adjunct of the *Minuteman* guidance system aimed at correcting trajectory errors and thus reducing the CEP on target.

Advanced Asroc: Why Bother?

One of the line items in the Navy's Fiscal Year 1965 budget is for work on an extended-range *Asroc*. However, observers familiar with the Navy's ASW program question the reasoning behind the project. They say that since *Asroc* and *Subroc* already exceed in range capability the detection range of Navy sonar devices, the emphasis should be on extending sonar ranges rather than weapon ranges.

ESP Communications Potential Raised

An Air Force scientist has made a strong plea for investigation of extrasensory perception as a possible method of communicating with astronauts in deep space. Dr. Everett F. Dagle of Cambridge Research Laboratories says a good, scientific research program should be begun now. Even if it shows that the idea is useless, Dagle declares "no greater service could be performed than to show that these chimeras can only lead the scientist and layman alike down the primrose path to delusion."

Winged Ferry Available by '70

A winged ferry vehicle for use with the *Manned Orbiting Laboratory* could be ready for testing around 1970, says Maj. Gen. Marvin C. Demler, commander of AFSC's Research and Technology Division. He estimates that the vehicle could be on hand two years after the first manned launches in the *MOL* program.

INDUSTRY

GD/A Savings Top Expectations

General Dynamics/Astronautics reports cost reduction and value control savings during the first quarter of 1964 of $18.5 million—more than double the division's $7-million savings goal for the period. The biggest cost-reduction gain resulted in a $13-million saving for the Air Force, accomplished by trimming microfilm requirements, detailed drawing descriptions and other items involved in handling of *Atlas* weapon system engineering data.

Fuel Cell for Apollo Exceeds Mission Needs

A fuel cell powerplant being developed for the *Apollo* program by Pratt & Whitney has produced substantially more electrical power than the 14-day supply the astronauts will require on their Moon mission. The company says endurance tests conducted for more than 400 hours in a simulated space environment showed that total electrical energy generated by the cell—three of which will be used on *Apollo*—exceeded normal total-energy demand foreseen for any one fuel cell powerplant used on the mission.

JPL Dedicates New Command Center

NASA's new, $14.6-million Space Flight Operations Facility (SFOF) opened last week at Jet Propulsion Laboratory is capable of handling two space flight missions concurrently and monitoring a third. The three-story plant already is being expanded to handle four missions simultaneously. Designed for use on unmanned missions, the center will get its first workout with the launch of the seventh *Ranger*—now deferred until the third quarter.

INTERNATIONAL

Russians Warm at COSPAR

Soviet delegates to the COSPAR meeting in Florence, Italy, were extremely cautious about discussing future manned spacecraft launchings—in fact, there was a notable absence even of rumors about new Russian space spectaculars. Other delegations reported that the USSR group was very cooperative in discussing its space program, which apparently is more broadly based than previously. The Russians were also well prepared; many of their papers gave hard data and a number were presented in English. For the first time in memory, two Soviet papers (on the formation of the ionosphere) were in disagreement.

Saudi Arabia Seeks Rocket Buildup

The government of Saudi Arabia is officially negotiating with both Britain and the U.S. for new rockets and jet aircraft to modernize its air force in the face of the new outbreak of fighting in Arabia. Under a plan still to be worked out, equipment would be purchased from both countries, with Britain presumably supplying *Thunderbird* surface-to-air guided missiles.



The picture is changing rapidly in the United States and throughout the world. Major military, political, social and economic policy shifts affect the lives of millions. But the demand continues and even expands in many areas for highly qualified men and women. In aircraft, aerospace, communications, missiles and ordnance as well as in many fields of civilian industry the need for education, experience and specialized skills and talents creates thousands of good paying positions.

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The Missile/Space Week

Ranger VII Launch Slipped

The launch date for *Ranger VII* has been postponed from a hoped-for late June date to sometime in the third quarter of the year. The slip was recommended by NASA's Jet Propulsion Laboratory and approved last week by Dr. Homer E. Newell, associate administrator for space sciences and applications.

Reason given for the postponement was a desire on the part of JPL to more thoroughly check and review tests being made on the spacecraft.

Shots of the Week

NASA's *Little Joe II* was used May 13 to test the launch escape system for the *Apollo* spacecraft. First indications were that the shot, from the White Sands Missile Base (N.M.), was successful, although one of the three 88-ft. landing parachutes malfunctioned. The escape system's main chute system was supposed to deploy at 12,800 ft., but a preliminary report was that it did not deploy until it reached 7,500 ft. Test was first in a series of five unmanned missions to develop and demonstrate the escape system.

- The Air Force on May 7 launched a *Minuteman* ICBM from a Vandenberg AFB, Calif., silo. The missile's payload, a mock nuclear warhead, landed within its target area some 5,000 mi. down the Pacific Missile Range.
- A hot run of the Kiwi-B-4D nuclear reactor was conducted at Jackass Flats, Nev., on May 13. NASA and the Atomic Energy Commission reported that the firing appeared to be successful, but conclusions will not be available for several weeks.

Lunar Orbiter Pact Formalized

The Boeing Co. has been formally awarded an $80-million contract to build five *Lunar Orbiter* spacecraft (M/R, Jan. 6, p. 13).

Kodak Eastman Co. will build the craft's cameras and Radio Corp. of America, its power and communications subsystems.

SNAP-9A Launched

The Atomic Energy Commission has disclosed that a SNAP-9A nuclear generator launched by the Air Force last month from Vandenberg AFB, Calif., did not go into orbit. The launch attempt had not previously been revealed.

At least two SNAP-9A generators achieved orbital operation last year as power sources for the Navy's *Transit* navigation satellites.

Demler Stresses Research Needs

The possibility of a structural or flight control failure in a spacecraft during re-entry requires the development of special escape devices to ensure the safety of the space pilots, Maj. Gen. Marvin C. Demler, Commander of the Research and Technology Div. of the Air Force Systems Command told the Aerospace Industrial Life Sciences Association convention.

If the spacecraft is disabled during re-entry, the escape will have to be effected through the use of a separable section of the vehicle capable of re-entry on its own. Weight limitations rule out, Demler said, consideration of "any thing that doesn't contain, in part, portions of the primary vehicle."

However, if the emergency occurs in space prior to re-entry, three possible approaches could be used to effect escape. First, the trouble could be isolated so that survival of the vehicle is possible. Second, emergency self-contained "space life boats" could be used until rescue could be effected by a vehicle launched from earth or from an orbiting space station. And finally, the escape vehicle could be made capable of re-entry, but again the weight penalties involved in this approach appear prohibitive.

AF Gets New Research Devices

Two new microelectronic research devices—an infrared search-track assembly and a PCM (Pulse Code Modulation) telemetry encoder—have been delivered to the Air Force's Avionics Laboratory at Wright-Patterson AFB, Ohio.

The units, developed by the Westinghouse Air Arm Div. in Baltimore and by Texas Instruments' Semiconductor and Apparatus divisions in Dallas, were displayed at the three-day National Aerospace Electronics Conference in Dayton last week. Air Force officials said both units demonstrate the expanding capabilities and

availabilities of functional electronic blocks for military systems.

Using a mosaic detector, the infrared search-track assembly (M/R, Feb. 3, pp. 28 & 36) has two primary modes of operation—a coarse-track mode, which includes acquisition, and a fine-track mode for precision tracking after target lock-on. Using the molecular electronics and mosaic detector techniques, Air Force project engineers said, the assembly provides high sensitivity and tracking accuracy meeting performance specifications of an operational system.

Designed for general aerospace applications, the system requires no rotating parts or bearings in the search and track phases. The molecular tracker uses both digital and analog-type integrated circuits, although major emphasis was placed on analog circuit development.

TI's semiconductor functional electronic block PCM telemetry encoder also demonstrates the feasibility of this technology in operational equipment with a digital and analog circuitry interface, the Air Force says. A variety of circuit types evolved as a result of this effort. These include amplifiers, a limiter, a stable voltage reference, an optoelectronic multiplex switch, a clock pulse generator and power switch drivers.

The encoder contains some 150 digital and 100 linear functional electronic blocks with separate associated feedback networks, all in flat package-stacked assemblies. The encoder, containing 16 analog input channels and 5 parallel-input 8-bit digital channels, is about 3 in. square and 1½ in. in height.

NASA Re-Schedules SA-6 Shot

Discovery of small metal particles in the second stage oxygen tank has caused an anticipated delay of approximately one week in the launch date of the sixth *Saturn I* vehicle (*SA-6*), originally set for May 20.

The delay is necessary to permit workmen to clean the tank and find the source of the particles.

Instrumentation Costs Cited

The cost of spacecraft instrumentation has reached the point where it is at least equal to that of the carrier launch vehicle. Many of the payloads on the *Thor* and *Atlas Agenas* already exceed in cost that of the rocket.

"With vehicles becoming a relatively smaller fraction of the national space budget, instrumentation will become, conversely, a larger and growing fraction of this budget," said Kurt R. Stehling in the keynote speech to the Instrument Society of America in New York City last Wednesday.

The speaker, assistant to the president for astronautics, Electro-Optical Systems, Inc., Pasadena, Calif., said that the instrumentation industry must recognize that the cost of spacecraft instruments should be kept realistic enough to prevent serious reaction by government aerospace planners who will face increasing scrutiny of their budgets by Congress during the next decade.

Vinson Given AF Award

Rep. Carl Vinson (D-Ga.) has received the U.S. Air Force Academy's third annual Thomas D. White National Defense Award for contributions to the national defense and security.

Dr. Edward Teller was the first recipient of the award, and the late Dr. Theodore von Karman won the White citation last year.



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AMERICA ENTERS
AS THIOKOL'S VAST SPACE BOOSTER COMPL

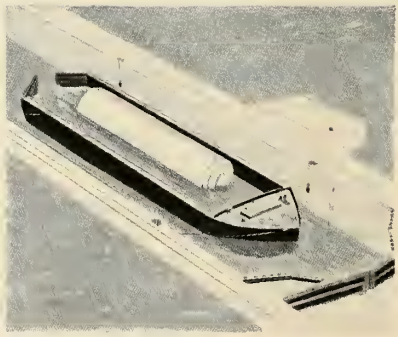
The giants are coming. The giant solid boosters that measure thrust and payload in multi-tons.

Thiokol's vast Space Booster Plant located in southeast Georgia's coastal country is completed and moving into operation.

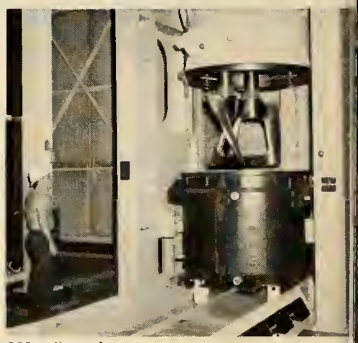
Under contract to the U.S. Air Force, Thiokol is building there the largest solid fueled rocket motors in the Free World. The first will be 156-inches in diameter, capable of 3,000,-000 pounds of thrust. It's to be static tested this year.

Two other demonstration motors with 260-inch diameter and 75 foot length (yet only half the length of the largest motor envisioned) will be fired next year.

To meet the task, Thiokol has built the most advanced solid rocket plant



Barge handling big booster



300 gallon mixer

The Anatomy of Thiokol's Space Booster Plant

possible within the current state-of-the-art. Its eleven major operating buildings, its supporting structures and handling equipment are all engineered on a huge scale. Cast, cure, and test pit is over 50 feet wide, 120 deep, has six foot thick reinforced crete walls on a twenty-six foot

The fully automated equipr and plant flow process are desi



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r round the clock operation, maxi-
um control and minimum delay in
otor loading. The propellant mixing
ant, for example, can manufacture
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(Illustrated right) Ultimate prod-
t of the Space Booster Plant will be
solid fueled motor generating over
000,000 pounds of thrust. These
otors used in clusters and combined
th a second stage could put into



low earth orbit payloads of 500 tons. Such a vehicle (largest) is shown in the illustration compared to other solid boosted launch vehicles.

ENGINEERS • SCIENTISTS Challenging openings exist at the Space Booster Plant. Live and work in this comfortable resort area on the Atlantic Coast. Needed immediately are an Aerodynamicist, Structures Engineer, Research Mathematician, Stress Analyst, Gas Dynamicist, Pyrotechnics Engineer, Thermodynamicist, and Reliability Statistician. Senior professionals required in most cases. For full details, contact Mr. Robert Malm, Thiokol Space Booster Plant, Brunswick, Ga.

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Nike-X Fate Keyed to DOD Study

Part I of a two-part series on Nike-X; Threat Analysis Study provides McNamara with up-to-date basis for production decision

by James Trainor

ONE OF THE most comprehensive studies ever conducted by the Dept. of Defense is under way in order to provide Secretary Robert S. McNamara with the broadest possible base of information on which to make a decision on production and deployment of the *Nike-X* antimissile missile system.

Most of the work is being directed by Maj. Gen. Austin W. Betts under the Army's Chief of Research and Development.

Ordered by McNamara last July, the Threat Analysis Study covers every conceivable aspect of the *Nike-X* question—including the strategic implications of deployment, arms control problems, the "Nth country" problem, levels of deployment, NATO, and the Soviet ICBM threat as well as Russian progress on ballistic missile defense. Finally, war game scenarios are being conducted to postulate the various ways in which nuclear war could occur and to demonstrate the defense contributions of an anti-ballistic missile system at various deployment levels, in combination with various other "damage limiting" forces and with varied levels of civil defense preparedness.

"Damage-limiting" forces is a key concept in Defense planning. Along with "assured destruction" it provides the two criteria on which DOD makes its decisions on force levels in the Strategic Retaliatory and Defensive Forces program packages.

Assured destruction determines the number of *Polaris* missiles which should be deployed and, to a lesser extent, the number of *Minutemen* and the size and composition of U.S. bomber forces.

The damage-limiting concept groups together the strike forces, passive measures such as civil defense, and employment concepts which reduce the level of damage to the U.S. Not widely known is the fact that the majority of the *Minuteman* forces as well as most of the bomber force falls into this category. These are the missiles and planes which are targeted on Soviet missile sites and airfields—as opposed to Russian cities. *Nike-X*, since it falls into the damage-limiting category, must compete not only with civil defense but also with *Minuteman*, B-52 and B-58 forces.

One war game scenario showed that, without a civil defense program and without an ABM system, there would be 144.3 million fatalities in a massive Soviet attack. With a civil defense program, this figure would drop to 96 million; with both a shelter program and a *Nike-X* system, losses would be cut to 68 million. However, Defense officials stress that such figures are extremely sensitive to the assumptions made on the timing of the Soviet attack and the methods used to carry it out.

This illustration does point up, however, the reasons for DOD insistence on an effective civil defense program. The lives to be saved by this relatively simple step represent a greater percentage of the population than those saved with an ABM system—and at a lower per-capita cost.

Secretary McNamara recently estimated the cost of *Nike-X* at $15-17 billion, with annual operating and maintenance costs of $2 billion. This would be for a system to protect "some 20-odd metropolitan centers, containing some 35% of the population." The cost of *Nike-X* then works out to be approximately $700 per person. Similar studies have shown that a shelter program which would assure the survivability of a greater percentage of the population would cost between $20-25 per person.

● **Threat analysis studies**—Another of the areas under study involves a question voiced by an official who until recently held one of the most influential positions in Washington: "Even if we can develop an effective ballistic missile defense system, should we deploy it?"

Leaving aside the not inconsiderable questions of resources allocation, the attitude behind this query holds that an ABM system is a destabilizing influence on the arms race. Rather than increasing the national security, according to this school of thought, the ABM would actually decrease our security by adding another spiral to the arms race—thus destroying the stability introduced by mutual deterrence.

Dr. Harold Brown, Director of Defense Research and Enginering, summed up this philosophy that unlimited arms development does not necessarily add to national security in testifying before the Senate Foreign Relations Committee on the Nuclear Test Ban Treaty.

"I don't consider arms limitation and arms development opposites," he said. "I think they are both opposites of the same coin. They are both roads that I think we have to pursue to improve our security. So long as we are in an arms race, we have to do all that we can do to improve our security, and that is what we in the Defense Department have been working on but that hasn't produced security for us."

Thus, unilateral disarmament—the preferred term is "mutual example," because of its less odious connotations—is a major factor in the *Nike-X* analysis. Just as the U.S. has unilaterally disclaimed any interest in orbiting bombardment systems and has, under the concept of mutual example, cut its production of fissionable materials, so could the *Nike-X* be held in abeyance until a clear need materialized.

On the other side of this question is the argument that deployment of a *Nike-X* system by both major nuclear powers would open the way to limited disarmament. Missile defense systems would provide a safeguard against enemy duplicity or chicanery while agreements were worked out to reduce the numbers of long-range offensive weapons. Although this concept has not

yet received as much study and analysis as has the arms limitation argument, it too is an important aspect of the threat analysis study.

● **NATO and Nth Country questions**—An ancillary consideration is the possible introduction of *Nike-X,* or a derivative, into NATO as a means of providing protection to Europe against the large Soviet medium-range missile force. This, perhaps more than the multilateral force (MLF) or any other program, could provide coalescence in the alliance. One Defense official feels, however, that Europeans may be so enamored with the idea of a *détente* that they would reject the defensive system on the basis that it might upset further East-West understanding.

More than any other consideration, the Nth country problem may be the deciding factor in the deployment of *Nike-X*. In spite of the nuclear test ban, the Defense Department is concerned that the present four-member nuclear club may be expanded. Eight countries at present have the resources and talent to develop nuclear weapons and at least a rudimentary means of delivery. By 1975, it has been estimated, there may be 15-20 such nations.

Although both the U.S. and the USSR are moving away from positions which involve a spasm response to attack, there is still a fear that a small country could involve the major powers in a nuclear war. A ballistic missile defense system could provide a means of countering small attacks such as these, protecting the population and buying even more time for a considered, controlled response.

● **Effect of Soviet moves**—Most obvious impetus to U.S. deployment of a *Nike-X* system would appear to be the deployment of a ballistic missile defense system by the Soviet Union. Nevertheless, although some Defense officials point out that pressures to deploy such a system in the face of clear evidence that the Soviets had done so probably would be irresistible, they stress that U.S. moves are not directly coupled to Russian actions.

Improvement of offensive systems—through use of more sophisticated decoys, multiple warheads, precursor warheads and just plain increases in force-structure size—could offset the huge capital investment required for ballistic missile defense. For every dollar spent on improvement of offensive systems to insure their penetration, the defense would have to spend three dollars, according to one DOD estimate.

It is also pointed out that the Russians have traditionally put more of their resources into air-defense systems; the U.S. has concentrated more on offensive weapons.

● **Quarterly reports**—The Threat Analysis Study has no clear and definable cut-off date and is not tied to a definite date for presentation of its findings—although obviously it is keyed somewhat to the budget cycle. Instead, in each quarter the progress to date is presented to the Secretary of Defense in an oral briefing, and a more formal written status of the study is submitted to the Secretary through Army channels. So far there have been two presentations to McNamara; the third is scheduled for early this summer. The reports are so constituted that any one of them could enable the Secretary to make a decision on production and deployment of the system.

Surprisingly enough, Gen. Betts has only one officer on his staff. The body of the work is done by civilian contractors. Hudson Institute is under contract to the Army to assemble and present the threat analysis results, both pro and con. Bell Telephone Laboratories, prime contractor for the *Nike-X* system, has set up a special group—similar to Bellcom and Intelcom—on technical aspects of the anti-ballistic missile system.

A Stanford Research Institute team located at Huntsville, Ala., is making a technical threat analysis; another SRI team at Menlo Park, Calif., is conducting the economic and strategic analysis. General Electric's Tempo Div. and Missile and Space Vehicle Dept. also are making inputs to the economic and strategic problem.

The Institute for Defense Analysis has contributed a Fire Damage Study to the program and is making a detailed analysis of the ICBM threat which covers "all the things they can think of," including decoys, ECM, chaff *et al.* IDA's Research and Engineering Div. has also made studies of "bits and pieces" of the ABM problem but has not studied the whole picture.

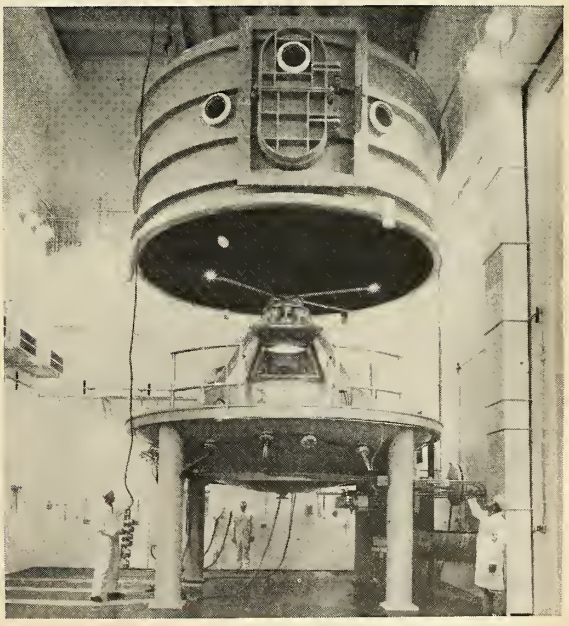
GE's MSVD and Avco Corp. have been awarded contracts under which they will present the toughest targets which can be postulated for 1970-80.

In addition, the Atomic Energy Commission's Livermore and Los Alamos laboratories and the Sandia Corp. are contributing indirectly with studies in the specific areas of warhead vulnerability and hardening.

Within the Government, routine inputs are made to the study by the Joint Chiefs of Staff, in addition to the Central Intelligence Agency and Defense Intelligence Agency. Basic technical information on the *Nike-X* system comes from the project office at Huntsville, Ala. In addition, the Threat Analysis Study is tied in closely with the Advanced Research Projects Agency's Project Defender program, which feeds in $100 million of information a year.

The overall cost is "a relatively few million dollars a month."

(Part II will cover the technical progress of the Nike-X *program to date—the intercept tests at Kwajalein, the advances in communications, electronics and "techniques of engagement" which led Dr. Brown to comment that* Nike-X *"appears to be the best active ABM system, from the point of view of cost effectiveness, that we will be able to achieve over the next 10 years.")* ■



Developing Environment for Apollo Crew

SCIENTISTS at North American Aviation Inc.'s Space Division, Downey, Calif., prepare metal vacuum cell and Apollo crew compartment for manned tests of environmental control system designed to produce livable surroundings for astronauts. Tests are being conducted for NASA's Manned Spacecraft Center. Fifteen-ton dome encloses spacecraft.

At 35th ASMA meeting . . .

Scientists Debate Effects Of Magnetic Shielding On Heart, Blood Cells

by Heather M. David

BAL HARBOUR, FLA.—Navy scientists have urged a cautious approach to exposing human beings to high magnetic fields such as those being considered for use in shielding spacecraft.

Dr. Dietrich E. Beischer and James C. Knepton, Jr., of the Naval School of Aviation Medicine, Pensacola, Fla., told those attending the Aerospace Medical Association's 35th annual meeting here that such fields may have a noticeable effect on the behavior of the heart.

In the liveliest session of the four-day meeting, scientists disagreed on everything except the need to investigate the physiological effects of magnetic fields. All urged formation of a magnetic research facility large enough to conduct whole-body research.

● **Magnetic protection**—The Beischer-Knepton group has been investigating these effects under contract to the Office of Biotechnology and Human Research in NASA's Office of Advanced Research and Technology. High magnetic fields may have use in shielding astronauts against cosmic radiation, ion propulsion, energy storage and other applications, Dr. Eugene Konecci, OART's chief of biotechnology and human research, told MISSILES AND ROCKETS.

Dr. Cornelius Tobias and N. M. Amer also have reported that high magnetic fields, around 3.5 kilogauss, appear to have a protective effect against high doses of ionizing radiation.

Significant disturbances in the white blood cell count of mice exposed to inhomogenous magnetic fields—a drop of 28.1%—were reported by a Westinghouse research and development laboratory group led by B. D. Fremming. An increase in red blood cells occurred in mice exposed to a homogenous field for 14 days.

Fremming said these effects might be either beneficial or deleterious, but at this point only serve to point up the fact that there is a whole-body effect.

● **Heart effects**—In a Navy experiment, squirrel monkeys subjected to high magnetic fields (from 20,000 to 70,000 gauss) at the Naval Research Laboratory, Washington, D.C., experienced a decrease in heart rate up to as much as one-fourth and a marked change in the rhythm of the heart. While such effects may not be profound enough to damage the heart, doctors feel they would produce a detriment in performance and perhaps even blackout.

The researchers cautioned that since this marks the first research of this type, firm conclusions should not be drawn; other environmental changes might have contributed to the effects. The researchers will report soon on the effect on brainwaves after exposure.

Beischer has also reported that sea urchin eggs exposed to 140,000 gauss have been retarded in their development, possibly during mitosis. However, drosophila malanogaster (the common fruit fly) had no effects after two hours' exposure to high gauss.

The Navy also reconfirmed that astronauts traveling on the surface of the Moon probably will not be greatly affected by the near absence of a magnetic field. These experiments were made about two years ago using the Hemholtz coil (M/R, Apr. 23, 1962, p. 22) at the Naval Ordnance Laboratory, which was energized to counteract the geomagnetic field. Although results have not yet been fully reported, Dr. Beischer disclosed that there appears to be some slight effect on eye movement.

The Navy group also reported on a new development in magnetic research—the magnetocardiogram. This could be used to make cardiac observations at a distance, doctors said. ■

Oxygen Deemed Safe for 30-day MOL Mission

BAL HARBOUR, FLA.—The work profile of the *Manned Orbiting Laboratory* astronaut may determine the kind of atmosphere used in the orbiting vehicle, Air Force doctors have said.

School of Aerospace Medicine scientists, led by Dr. Billy Welch, gave the first documented report on the two 30-day, 100% oxygen studies performed at the school. As in preliminary reports (M/R, Feb. 10, p. 35), the SAM group said that they can now accept the use of 100% oxygen for the 30-day period. Welch, however, termed "conservative" the AF approach toward extending this to longer-duration missions without further tests.

The Air Force has also seriously considered the use of a two-gas, oxygen-nitrogen mixture at 7 psi. However, recent tests simulating the compression profile of the *MOL* mission (from 14.7 psi sea level atmosphere, to 5 psi in the *Gemini* to 3.5 psi in the extravehicular *Gemini* spacesuit, to 7 psi mixed gas atmosphere of the *MOL* back to 3.5 psi in the suit, then to the 5 psi in the *Gemini* for re-entry) has increasingly pointed up the problem of bends.

The critical point, said AF doctors at the Aerospace Medical Assn. meeting, comes during the change from the *MOL* atmosphere to the suit. The de-nitrogenization period has already been extended to 4½ hours because of the high incidence of bends in test subjects.

Thus, if the mission profile calls for a great many forays in and out of the vehicle, it may make the two-gas atmosphere less attractive because of the rather long periods that now seem necessary to prepare the astronaut for the change in atmosphere.

Saturn IB/Centaur Launch Vehicle Will Be Funded in FY '66

by Hal Taylor

MICHOUD, LA.—Support for a *Saturn IB/Centaur* launch vehicle appears to be growing, with Dr. Wernher von Braun flatly predicting funding for the three-stage booster in Fiscal '66.

At the same time, the Chrysler Corp. —prime contractor for the S-IB first stage—has begun a massive campaign to "sell" the booster as a future workhorse for the U.S. space program.

Von Braun, director of NASA's Marshall Space Flight Center, told MISSILES AND ROCKETS that "there will be money to develop the booster in the FY '66 space agency budget."

Other NASA officials here also agreed that the opinion favoring development of the *Saturn IB/Centaur* is growing.

● **Controversy stirred**—The increasing optimism comes in the face of fiery opposition of Air Force and NASA space science officials (M/R, May 11, p. 14). Those officials favor the *Titan III* booster for unmanned planetary missions in the 1970's, primarily because of alleged cheaper costs it will offer.

Informed sources report, however, that the three-stage liquid booster combination appears to be winning out for two reasons.

Dr. George E. Mueller, associate administrator for manned spaceflight, who will not have the final "yes" or "no" over the program, but who will have to concur in the decision, currently favors the *Saturn IB/Centaur*.

In addition, Associate Administrator Robert C. Seamans—who will make the final decision—is expected to favor the space agency's own *Saturn IB* booster over the Air Force-developed *Titan III*.

The same sources declare that the only previous roadblock to approval of the addition of the *Centaur* liquid hydrogen upper stage to the *Saturn IB* has been the lack of flight missions requiring its boost capability.

● **Missions forthcoming**—Von Braun, however, said that in addition to long interplanetary flights to Mars with the heavy *Voyager* spacecraft in 1969 and 1971, other possible missions are being studied.

One mission he detailed calls for launching two *Surveyors* with one launch vehicle. One of the photocraft would land on the lunar surface while the other would be placed into orbit around the Moon. This flight, he said, would only be made if it promised to provide data for the U.S. manned lunar landing program.

Such flights, the NASA official said, would have to be made in the 1967-1968 time period.

Von Braun also said he feels the three-stage vehicle can compete on a cost/effectiveness basis with the *Titan III*. He said that with the missions envisioned, a cost of $20 million per launch of the *Saturn IB/Centaur* is possible.

● **Chrysler argument**—In pushing greater use of the *Saturn IB*, Chrysler officials declared that the heavy investment in the program is "behind us," the system is in being "here and now," and it is not simply a "planned vehicle." The latter is apparently a veiled reference to the *Titan III*, which is still in the early development stages.

The officials said that with only modest increases in checkout equipment and one more static test stand, the Michoud vehicle plant would have the capability of turning out one *Saturn IB* first stage every month.

Dave Buell, chief engineer in the firm's advanced engineering branch, detailed the booster's growth capability in a briefing for reporters currently touring Project *Apollo* industrial facilities.

He said that addition of the *Centaur* to the Chrysler Corp. first stage and the Douglas Aircraft Co. S-IVB second stage would provide a payload capability of 24,000 lbs. in a 2,000-n.-mi. orbit; 14,000 lbs., for a circumlunar mission, and 10,000 lbs. for a Mars fly-by mission. The only modification required would be the adaption of a 154-in. shroud and required interstaging.

● **Strap-ons proposed**—Touching on other possible growth possibilities, Buell said that strapping on two 120-in. solid motors—with a thrust of 900,000 lbs. each—would increase the *Saturn IB's* payload capability from 35,000 to 66,000 lbs. in a 100-n.-mi. orbit.

Adding 30% fluorine to the liquid oxygen in both stages would enable the booster to put 50,000 lbs. in a 100-mi. orbit. ■

Gemini Circumlunar Flight 'Feasible'

MICHOUD, LA.—Dr. Wernher von Braun has told MISSILES AND ROCKETS that a manned circumlunar mission with the *Gemini* spacecraft is "feasible."

He added, however, that the only basis for undertaking such a mission would be for "political reasons" if the U.S. decides that it will not be possible to achieve the national goal of landing a man on the Moon by the end of this decade.

Von Braun said here last week he believes this country should stick to the job already begun—the successful culmination of Project *Apollo*.

The director of the Marshall Space Flight Center confirmed that the space agency has studied a possible circumlunar mission with the *Gemini* spacecraft.

He said studies have shown the project is completely within the state of the art.

He estimated its cost at $1 billion, but said that if a decision was made in 1965 to move ahead with the project, the mission could be made before the end of this decade.

Von Braun and other NASA officials here indicated strongly that the flight is not being given serious consideration at this point. It remains, however, as a possible project to salvage this country's prestige if the manned lunar goal proves impossible.

Nine firms bidding . . .

Study on Lunar Communications Due

NASA offers wide scope on proposals; Westinghouse plan detailed at 16th National Aerospace Electronics Conference

by Michael Getler

SELECTION OF a single contractor to make a funded six-month study of communications requirements for manned post-*Apollo* lunar surface exploration is expected within the next four or five weeks.

Nine firms have responded to a request for proposals made last month by the Marshall Space Flight Center: North American Aviation, Inc.; International Telephone & Telegraph Corp.; Page Communications Engineers; Raytheon Co.; Westinghouse Electric Corp.; Hughes Aircraft Co.; Bendix Corp.; Sylvania Electric Products, Inc.; and Radio Corp. of America.

Very few constraints have been placed on the technical scope of the proposals, according to NASA, allowing use of projected 1970 period state-of-the-art componentry, but keeping within the anticipated needs of the broad lunar exploration concepts now being developed by the space agency (M/R, May 11, p. 17).

A team of engineers from Westinghouse's Systems Operations Div. in Baltimore provided some timely insight into the types of systems being proposed by industry when it reported on its plan for lunar base communication last week at the 16th annual National Aerospace Electronics Conference (NAECON) in Dayton, Ohio.

● **Westinghouse system**—Engineers told MISSILES AND ROCKETS the system envisioned would weigh "on the order of 500 lbs." and make extensive use of redundant circuitry.

The communication center in the Westinghouse proposal is located in the main crew shelter. The center houses the electronics required to relay data from lunar surface locations and installations within line-of-sight (LOS) range of the center to Earth. To accomplish this, the center has an array of antennas including a small hemispherical-coverage S-band antenna for early operations, a larger S-band dish for the major Earth-tracking and communications needs, and a VHF antenna mounted on a 100-ft.-high mast for intra-base communications.

Communications with lunar roving vehicles out of LOS range, even with these mast-type antennas in service at both the center and on the rover, will be handled by configuring the rover with an S-band system similar to that in the central control station to provide the rover with a direct Earth link, and therefore, an indirect relay link between the rover and the lunar control station.

Westinghouse engineers say this approach appears more feasible than bringing to the lunar surface numbers of active repeater relay stations, or use of LF or MF surface wave propagation systems, although this latter approach, now believed to require excessive power, may prove to be of value once better data on lunar topography and soil characteristics are in hand.

● **Standby antennas**—The small S-band antenna will be erected during transit to the Moon or upon lunar landing. It will be used during the "standby" phase of operation, before the base becomes fully operational, to receive commands from Earth and to transmit low-data-rate telemetry base status data to Earth periodically. All lunar payloads must be able to survive a standby period of six months to a year on the lunar surface before crew arrival because of possible Earth-launch frequency limitations.

The main Earth-tracking S-band antenna, a 10-ft.-dia. parabolic disc, will handle all Earth-Moon data transmission and reception during the operational phase. The antenna reportedly will provide about 34-db gain. An infrared tracking system is used to keep the antenna pointed toward the center of the Earth.

Westinghouse engineers point out that the system requires no Earth-station tracking system as would be needed with antennas of larger diameter and narrower beam widths.

● **Lunar LOS distance**—The VHF antenna on the 100-ft. mast will give an LOS distance to the lunar horizon of slightly less than seven miles. Using similar antennas and masts at other locations and on the rover can about double the direct lunar communications link. The 100-ft. mast, according to Westinghouse, is made practicable by using the de Havilland Storable Tubular Extendable Member (STEM) technique. The self-erecting unit would weigh less than 10 lbs. on the Moon, and would have a maximum dimension of eight inches when collapsed.

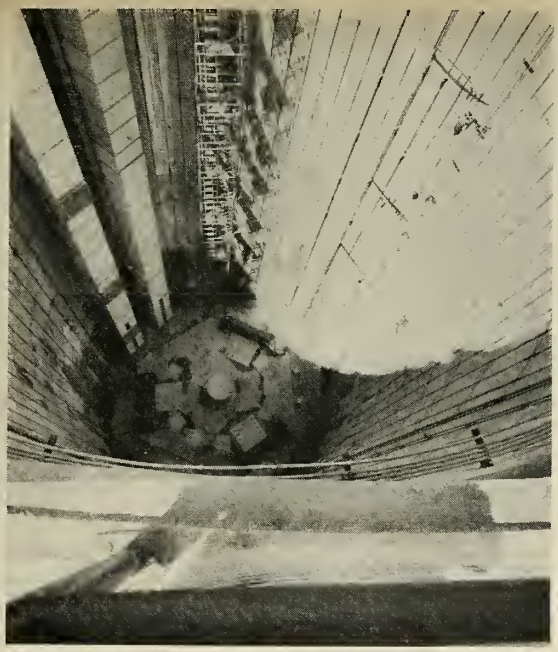
The S-band receiver, a single sub-carrier discriminator and the command decoder, would operate continuously during standby. Power required is less than 100 milliwatts. The same receiver is used for reception of commands, voice and video in the operational mode. When a status check is commanded, a programmer will turn on the shelter data system and shelter sensors will be scanned and data transmitted using the small S-band system.

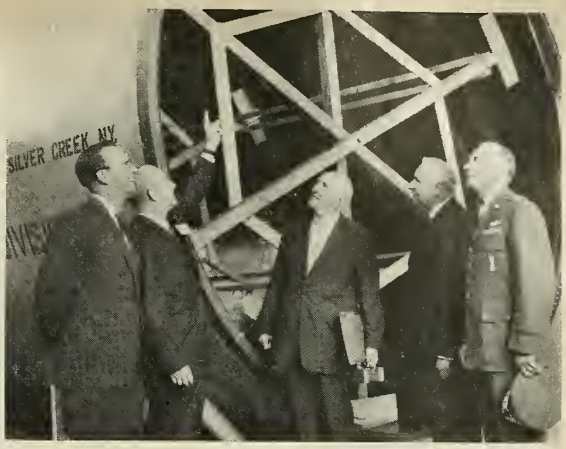
Less than five watts total input power is required for transmission rates of 500 bits/second during standby. The shelter data passes directly through a master frequency multiplexer—used during manned operation—and phase-modulates the S-band transmitter.

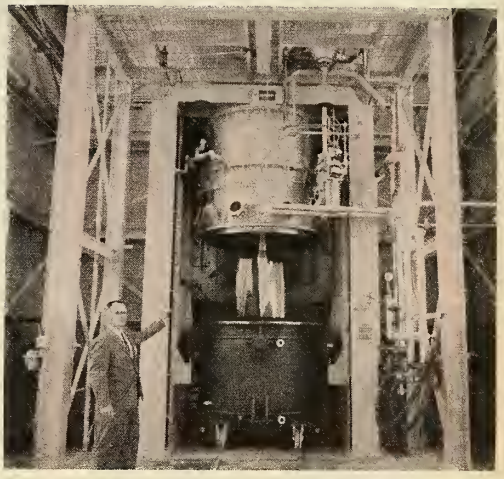
When the shelter is manned and operational and the 10-ft. antenna is in service, the digital data rate for the shelter system will be about 5,000 bits/second. Voice will be transmitted on a separate sub-carrier. The shelter video system will be used to transmit "commercial quality" TV pictures intermittently. Frame rates and lines per frame will be reduced so that baseband bandwidth will be about 0.5 mc.

● **VHF unit**—In the VHF system, a separate VHF receiver is provided for each location monitored. Each carrier is modulated by one or more sub-carriers carrying voice and data when required. The receiver outputs are fed to frequency translators, where frequency separation is accomplished.

The digital data and voice generated in the shelter are also fed to the translators. Finally, the master frequency multiplexer sums all the sub-carriers and feeds the sum to the S-band transmitter for Earth transmission. ■







ABOVE: Looking down into huge (53-ft.-dia., 120-ft. deep) cast, cure and test pit. ABOVE RIGHT: First 156-in.-dia. case section at plant is inspected by (l. to r.) Walter L. Berry, general manager, Space Booster Div.; Dr. Harold W. Ritchey, Thiokol executive vice president; Sen. Richard B. Russell (D-Ga.); J. W. Crosby, Thiokol president; and Brig. Gen. J. S. Bleymaier, deputy commander, AF Space Systems Div. RIGHT: 300-gal. paste preparation mixer.

Thiokol Dedicates Big Booster Plant

HORSE PEN BLUFF, GA.—Thiokol Chemical Corp. expects to begin static-firing 156-in. solid rocket motors in August at its $12-million Space Booster Plant here in southeast Georgia.

The new facility was dedicated May 8 in ceremonies attended by high-ranking NASA, military and industry officials. Keynote speaker was Sen. Richard B. Russell (D-Ga.), chairman of the Senate Armed Services Committee and ranking Democrat on the Senate Space Committee, who declared that the engines to be developed at the new plant "will enhance our booster technology—a vital pacing element in our overall space effort."

A feeling of cautious optimism pervaded the ceremonies, despite the fact that no contracts are definitely in sight for production of big solid motors beyond the 156- and 260-in. demonstration program now funded by the Air Force.

Space Booster Plant is designed to turn out high-quality propellant at the rate of six tons an hour. It uses the Automated Batch Weighing (ABW) system developed by Thiokol and Toledo Scale and earlier put into use at the Thiokol-operated Air Force *Minuteman* plant in Utah.

ABW employs a highly accurate scale operating in conjunction with automated material-handling equipment. A punched card fed into a computer directs delivery of a specified amount of each ingredient. The system double-checks itself by weighing the delivered raw materials on a second scale.

Each of the propellant processing buildings operates full-time, for top efficiency. Dual dumping systems in the equipment for delivering the aluminum powder and oxidizer afford continuous operation. Temperature controls are set as ingredients are combined, so that they arrive at the mixer building ready for mixing. This precludes delays in bringing the batch to mixing temperature.

● **Room to grow**—Altogether, the plant includes 12 operating buildings and a dock complex. Thiokol says it can easily be expanded to three times its present size and can use any of several processing methods.

The site is in an area of 50,000 uninhabited acres. Thiokol owns a 7,500-acre section in which the buildings are located and has leased another 7,500 acres that are used as a buffer zone between the complex and the populated area of Brunswick, Ga., nearby.

About 15 miles south of Brunswick, the site is 170 miles from Cape Kennedy via the Intercoastal Waterway. It has a dock on a deepwater alternative stretch of the Waterway.

(For a detailed first report on construction of the facility, readers are referred to MISSILES AND ROCKETS, Nov. 18, 1963, p. 26.) ■



Decision-maker's dilemma

There's no dearth of data for the decision-maker. He has miles and miles of magnetic tape, filled with plans, logistics, and data received from all over the world.

But it cannot help him make the right decision at the right time – until a way is found to analyze data from dozens of sources simultaneously and tell him what he needs to know. That is the crux of the Command & Control problem.

A model Command & Control system for a worldwide satellite network is in operation today in the Data Processing Laboratory of Lockheed Missiles & Space Company. Developed as a test facility for Air Force space programs, the model system uses the most advanced electronic computer and display equipment. The real thing in every sense – except that the incoming signals are simulated on tape – this model is giving Lockheed scientists and engineers the solid answers needed to cope with the increasing complexity of Command & Control.

LOCKHEED

Lockheed Missiles & Space Company, Sunnyvale, California – A Group Division of Lockheed Aircraft Corporation.

Technical Countdown

MATERIALS

Welded Module Report Released

The findings of an exhaustive 18-month research program on 3D welded module design and manufacturing have been released by General Dynamics/Pomona and the U.S. Army Electronic Research and Development Lab, Fort Monmouth, N.J. The study recommends the use of oxygen-free copper as a component lead material when copper is to be used. It also spells out the value of the measuring joint resistance as a non-destructive weld test method—and indicates that symmetrical distribution statistical methods can cause serious errors. Instead, the study advances the distribution-free analysis to depict true maximum strength values. The report is available ($2.00) by writing directly to Weldmatic Div., Unitek, 950 Royal Oaks Drive, Monrovia, Calif.

Inclusion-Free Yttrium Iron Garnet Rod Grown

Specialists at Microwave Chemicals Co. has successfully grown a ferrimagnetic single crystal rod of yttrium iron garnet (YIG) for the Navy. The rod, aligned along its 111 axis is 0.791 in. long, and 0.120 ±0.003 in. across. The single crystal is grown from a molten mass in which the solid and liquid states are maintained in continuous contact. Microwave Chemicals is growing a second rod of approximately the same dimensions. Ferrimagnetic materials exhibit large magnetic alignments that permit the ferrimagnetic crystal to interact with electric fields. Such compositions are useful in devices for operation at microwave frequencies.

ELECTRO-OPTICS

Meteor Photographing Net In Operation

A seven-state network of 16 unmanned automatic camera stations designed to photograph meteors is now in operation. The system, located in the Midwest, was designed by Smithsonian Astrophysical Observatory engineers under a $240,000 NASA grant. The space agency is particularly interested in the mass a body loses through atmospheric entry. Photos of the events may supply this information.

PROPULSION

Aerojet Checks Out Big Booster Plant

Aerojet-General Corp. has announced it has test-fired six solid propellant motors at its new $21-million rocket plant in Dade County, Fla. These were the first such tests there and were forerunners to processing and testing giant 3-million-lb.-thrust solid fuel rockets. Paul P. Datner, manager of operations at the new plant, said the rockets were fired (secured in the test stands) to prove the propellant quality is ready for production use in the large motors. He added the big boosters will be tested there early in 1965. The work in Dade is being done under the direction of the Air Force Space Systems Div., Los Angeles.

ELECTRONICS

Consumption Measurer for Heat Shields

Emerson Electric is developing a device to measure rate of consumption of an ablative heat shield re-entering the Earth's atmosphere. The "char progression sensor," designed for both wind tunnel and actual flight tests, measures by radioactive techniques repletion of virgin heat shield material and recession of resulting char layer. By activating through radioactive techniques those ingredients characteristic to only the virgin material or the char, depletion can be measured through a decrease in the characteristic counting rate. A solid-state detector is used to transfer consumption information to a counter, which changes the data to emf for telemetering, in the case of inflight test, or direct recording, in the case of wind tunnel flight simulation. Emerson's Thermal Systems Dept. is developing the sensor for NASA's Manned Spacecraft Center.

Ships Revamped for Gemini

The Rose Knot and Coastal Sentry data-acquisition ships are having their on-board instrumentation doubled to support *Gemini* manned flights. The work is being done in Norfolk, Va., shipyards. RCA says the modifications will not only permit gleaning data from the capsule, its pilots and the *Agena* rocket with which the spacecraft will rendezvous, but from the vessels the NASA flight controller team will also be able to command both vehicles, accomplishing functions ranging from turning on telemetry transmitters to firing the retro-rockets. Each vessel is gaining two pulse code modulated (PCM) telemetry systems, a digital command system, five display consoles, a digital computer, supporting communications and recording equipment and an auto-track antenna for quicker and surer acquisition of the spacecraft.

First One-Microsecond Cycle Memory Delivered

The Army Ballistic Research Labs at Aberdeen Proving Ground, Md., recently received the first of three large-capacity core memories capable of a 1-microsec. memory cycle. Developed by Ampex Corp., the LZ memory has a 16,384-word (72 bits/word) capacity and permits operating modes of read-restore and clear-write. Control signals are read-request and write-request. The 700-lb. subsystems will be used to enhance the lab's BRLESC (Ballistic Research Laboratories Electronic Scientific Computer), a general-purpose computer primarily employed to solve ballistics and weapon-system evaluation problems. The remaining two memories will be delivered by June, Ampex says.

LUNAR RESEARCH

'Fairy Castle' Theory Assailed by Scientist

The concept of a lunar surface made of "fairy castles" built up by minute particles of lunar dust sticking to each other has been severely criticized by Dr. Duane O. Muhleman, Jet Propulsion Laboratory scientist. Dr. Muhleman has done considerable research on lunar measurements with radar and radio. The fairy castle theory is said to be the most accepted one today. Muhleman, speaking before the recent American Astronautical Society meeting, said it is not necessary to hypothesize fairy castles to explain observed phenomena. Although he admitted that the concept is consistent with lunar measurements made, "A clever man in the laboratory could build other models of surfaces that would be equally consistent." Muhleman recommended using only measurements of lunar phenomena for *Apollo* design purposes and not "wasting time" imagining what the lunar surface looks until we get there.

Prototype Laser System Combines High Information Rate with Tracking Accuracy

Lockheed-built system has carried 5-mc TV signal with accuracy of 30 arc secs, contains basic features for space laser network; further studies planned, possibly in a space vehicle

by Rex Pay

SUNNYVALE, CALIF.—A prototype laser system for satellite tracking and communications has shown an angular tracking accuracy of 30 arc seconds and carried television signals with a bandwidth of 5 mc.

Its tracking and communications are carried out with common optics.

With a 100-milliwatt gas laser, the system could provide communications over a distance of 700 mi., with a bandwidth of 1 mc and a signal-to-noise ratio of 10 db—typical requirements for telemetry and voice communications with a spacecraft in a 300-mi. orbit.

Called LOCATS—for Lockheed Optical Communications and Tracking System—the prototype equipment contains the basic features that ultimately would be put into a space laser network.

● **Precision is demanded**—Because lasers offer high information rates on very narrow beams, with equipment that promises to be more compact than microwave devices, they look very suitable for communications over interplanetary distances.

However, although the laser's narrow beam gives it the capability of long-distance communication, it also means that transmitting and receiving sensors have to be pointed with great accuracy. A precision tracking system is essential.

Otto Schleifer, project engineer for Locats at Lockheed Missiles and Space Company, said the company-financed project had concentrated on the task of engineering the equipment to give it an integrated acquisition, tracking and communication capability.

He said that the present tracking accuracy of 30 arc secs. compared very favorably with the 200 arc secs. typical of precision radar. Even so, the present accuracy of the optical system could be improved by an order of magnitude.

The 30 arc-sec. accuracy was chosen with the knowledge that the first tests with the system would involve transmission through the atmosphere. As turbulence will deviate an optical beam by angles of 10 to 20 arc secs., an optical beamwidth of less than 30 arc secs. would lead to a very noisy communication channel.

● **In-space**—Ultimately the system might be used for communications between spacecraft, and narrower beams could be employed. One satellite might, for example, be carrying out high-resolution reconnaissance and transmitting the data over a laser link to a spacecraft. Or a satellite might be used as a relay between a deep-space vehicle and Earth.

In many applications there would be a Locats both at the ground station and in the space vehicle. Lockheed has designed the system so that critical components are compatible with the space environment and the equipment can be built into a space package with minimum effort.

Schleifer said Lockheed is thinking of proposing Locats as part of a larger experiment. If funds were forthcoming for this, Lockheed would be very anxious to test Locats in a space vehicle.

In the near future, Locats and a laser transmitter might be set up on an outdoor site to study the effects of changing atmospheric conditions on transmission of the light beam.

● **Existing setup**—The present laboratory system consists of a Spectra Physics helium-neon gas laser whose output beam passes through an ultrasonic modulator and lens system to the Locats receiver. This is mounted on a turntable provided with a sinusoidal movement to test the system's servo-tracking performance. A lens diverges the beam to simulate a path length of 3,000 ft.

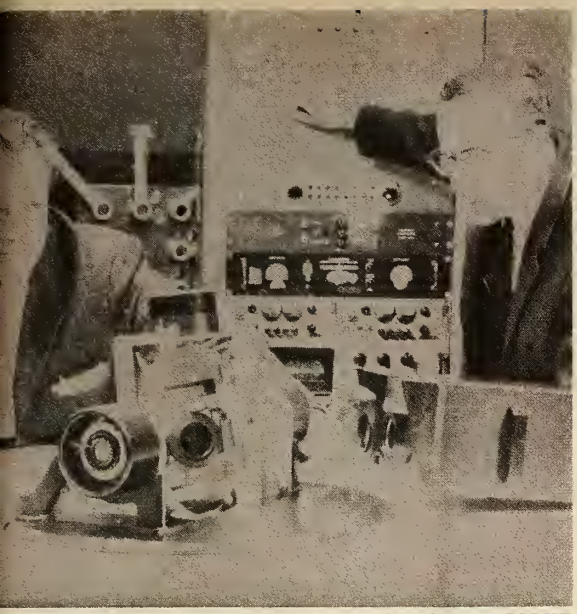
The present system operates at 6,328 Angstroms, but could be made to function at the wavelengths of ruby or neodymium emissions.

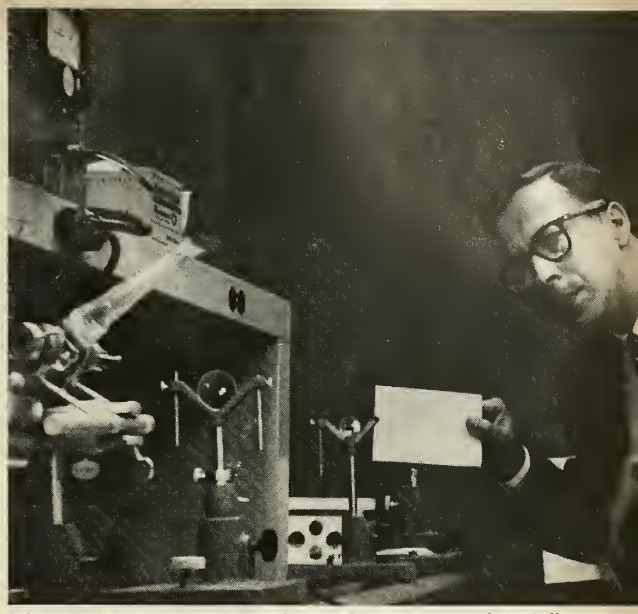
The ultrasonic modulator, which is used to impress a television signal on the beam, was developed by Dr. Harold Hance at Lockheed Missiles and Space Company. A quartz ultrasonic transducer fires a 30-mc carrier wave into a water-filled container and sets up a series of compressions and rarefactions that provide an analog of a diffraction grating for the light beam that passes through the cell. Because the velocity of light is much higher than the velocity of sound, the wave fronts are virtually stationary with respect to the beam.

The angle of the first-order diffraction from the main beam depends on the ratio of the optical and sonic wavelengths.

In the Lockheed modulator, 10% of the energy of the incident beam is carried in each of the two first-order sidelobes either side of the main beam (first-order diffractions). These side lobes are 100% modulated and one is selected by a mirror for transmission.

There is very little energy in higher-





LEFT: LOCATS tracking and communications detector. RIGHT. Laser beam emerging from the ultrasonic modulator has two side lobes. Each carries 10% of the incident energy and is fully modulated by the 5-mc video signal.

order defractions. The main beam is only modulated to 20% and does not provide as good a signal-to-noise ratio as do the side lobes. Lockheed expects to put nearly 100% of the energy into the side lobes with improved equipment later this year, said Schleifer.

In its present form the ultrasonic modulator has a bandwidth of 10mc, but theoretically this could be extended to several hundred megacycles.

For spaceborne use the liquid cell would be replaced by a solid glass cell, which would require increased driving power.

● **Acquisition & tracking**—The two optical and detector channels for acquisition and tracking/communications are mounted in the same box. A plane mirror (flat to within a quarter wavelength) forms the moving part of the detector system that captures the incoming beam and directs it into the two optical channels.

The acquisition and tracking system makes use of a "Reconotron" image-dissector tube made by CBS Laboratories. This has a resolution of 500 lines per in. and in the present system is equipped with a photocathode with an S20 response. It could, alternatively, be equipped with a photocathode with an S1 response, which would make it useful for wavelengths out to 1 micron.

The acquisition lens has an aperture of 1 in. and provides a field of view of 10° by 5°. This was selected on the assumption that the ground station would have orbital data on the satellite that is to be acquired.

Before acquisition, light passes through the wide-field optics to be reflected by a small mirror into the image dissector. When the image dissector provides a signal that indicates the position of the incoming laser beam, this is compared with the pointing angle of the plane mirror and an error signal is derived. The error signal drives a servo system that points the plane mirror accurately at the laser source.

When the laser beam enters the narrow-field optics it passes through a partially silvered mirror which reflects 95% of the beam into the communications detector (a photomultiplier) and transmits 5% of the beam to the image dissector. Confirmation of tracking causes a solenoid to remove the small mirror from the wide-angle beam path, so that tracking continues through the narrow-field optics alone.

The narrow-field lens has a field of view of 1° by ½° and an aperture of 2 in. Behind it, a spectral filter with a pass-band of 3 Angstroms suppresses background radiation. The photomultiplier is only one of a number of possible detectors. A photo traveling-wave tube operating at frequencies up to 9 kmc could be used.

The signal from the electrostatic image dissector passes to a second-order servo system, which tracks with zero-dynamic following error when the input velocity is constant. Residual errors are static pointing errors and acceleration errors.

● **Slight acceleration**—The system has been designed this way because in low-altitude satellite orbits (300 mi.) the satellite velocity at a zenith angle of 40° is about 0.7° per sec. when overhead, whereas acceleration is quite small—about 0.007° per sec. per sec.

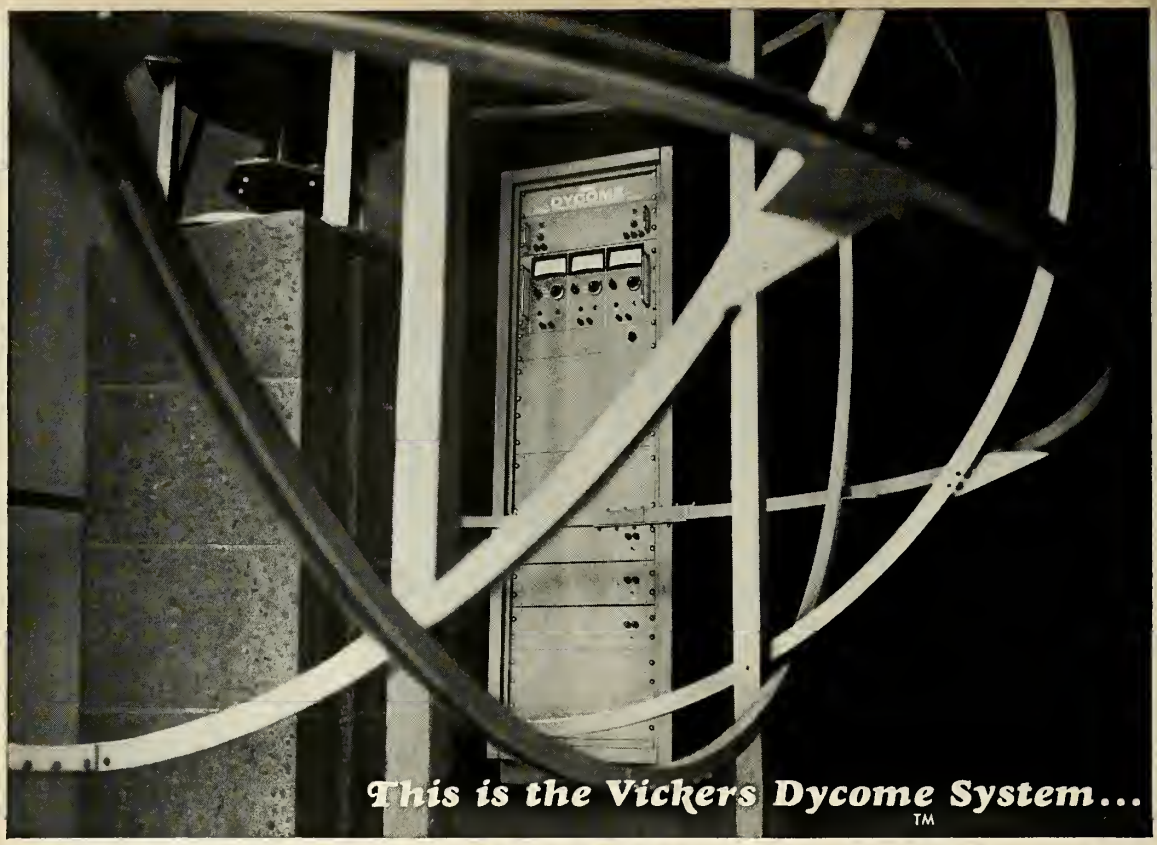
With space conditions in mind, the plane mirror that deflects the incoming beam is gimballed in flexure pivots instead of some form of bearing. A brushless d-c torque motor is mounted on one end of each gimbal and a tachometer of similar design is mounted at the other end, together with a resolver.

The tracking servo is made up of three loops. The main tracking loop looks into an inner loop that contains the resolver, which in turn looks into the innermost loop. This contains the torque motor and tachometer. The tachometer gives rate damping; the resolver enables a prepositioning command to be given and also provides the correct transfer function.

Although the gimbals restrict the mirror rotation to an angle of ±30°, the reflected ray passes through twice this angle, and the restriction is not considered serious.

The system takes about 1 sec. to acquire a signal, chiefly due to a delay built into the system to prevent it locking onto noise. If the signal is lost, the system immediately reverts to wide-field acquisition mode.

For very narrow beams transmitted over many millions of miles, an interferometer system, possibly using a second mirror, would be used to get a tracking accuracy of 1 arc sec. The image dissector would provide initial acquisition, then a switch would be made to vernier tracking using the interferometer. ■



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VE93-2

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Circle No. 16 on Subscriber Service Card

Dow Corning Tailoring Silicone Work To Meet Individual Needs of Buyers

by John F. Judge

MIDLAND, MICH.—A major shift in marketing and a new management concept are the tools being used by Dow Corning Corp. with its versatile silicones to meet the materials challenges of the missile/space/aviation fields.

Silicones represent a materials spectrum as complex as classical organic chemistry, and the Dow Corning method has always been to approach the customer on a product basis.

With the creation of an Aerospace Materials Group, the firm is concentrating its talent to meet specific materials needs and applications—by tailoring silicones to the customer's demands.

John Tyner, Dow Corning's Aerospace Marketing manager, says silicones are no longer the last resort. The temperature regimes and other physical characteristics of operational systems are now reaching the functioning areas of silicones.

A group of aerospace application labs has been set up in Midland to handle advanced research, test and development work on all silicone formulations of interest to aviation/space concerns.

The man-made family of materials is being used from re-entry shields on the *Gemini* capsule through liquid lubricants—with fluorosilicone sealants, molding plastics and potting/encapulating in between.

● **Re-entry rubber**—The white, flowable silicone elastomeric material forming the prime re-entry heat protection system on the *Gemini* spacecraft is Dow Corning 325. The compound cures to an elastomer through the addition of a special catalyst. The cure takes place at room temperature or slightly elevated temperatures in 12 to 24 hours.

The cure can be cut to four hours at 150°F or 15 minutes at 300°F.

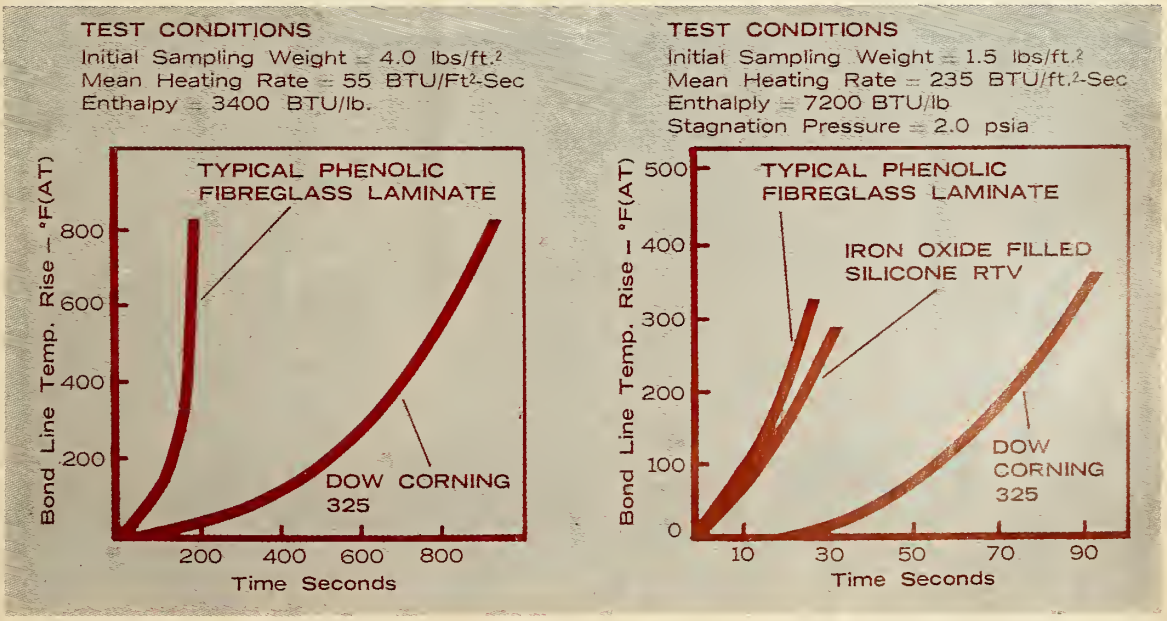
The material can be cast, troweled or molded onto a surface. Excellent adhesion is achieved by first coating with Dow's Silastic RTV 1200 primer.

DC 325 is a char-forming ablator. The char strength and adherence is termed "excellent" by Dow engineers. The unique characteristic of the material is its swelling action during char formation.

The swelling—combined with low thermal conductivity, high specific heat, low density and char stability—produces an effective heat shield. The material remains flexible in the cured state and this eliminates thermal stress problems.

● **Performance**—Dow Corning scientists claim the material's performance is outstanding at low fluxes and at least equal to other good ablators at high heat fluxes. But the claims are coupled to the caution that performance of any material is dependent on a combination of conditions such as flux, enthalpy, pressure and shearing stresses.

Exposure to heat fluxes above 11 BTU/ft²/sec results in formation of a strong carbonaceous char with a density of about 25 lbs/ft³. At fluxes ex-



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ceeding 180 BTU/ft²/sec, surface recession occurs dependent upon pressure and enthalpy, but the glassy coating formed on the surface is extremely viscous and resists even supra-orbital shearing stresses. The strength of the cooled char area is greater after higher heat fluxes.

Immediately beneath the expanded char layer is a very thin heat-affected zone and below this is the virgin, elastic material. In general, high pressure and low enthalpy cause a surface gain while low pressure and high enthalpy cause a surface recession.

Since the material is trowelable, imperfections in fabricated parts can be easily repaired by cutting out the defective section and re-applying the compound.

● **Silicoketones**—Silicones are polymeric hybrids—and more properly called organo-plysiloxanes. They are condensation polymers having a silicon-oxygen-silicon linkage instead of the organic carbon-carbon molecular skeleton.

The basic Si-O-Si skelcton can be modified through a number of diverse —and growing—reactions resulting in classes of materials best categorized as fluids, elastomers and resins. Thus the whole field is analagous to carbon chemistry.

This ease of comparison with the more highly advanced field of organic chemistry is both a boon and a bane to the development of silicones. The similarity in structure and in the formation of various polymeric materials disappears with the examination of end-product physical and chemical characteristics. Even the similarity in formation is slight, since a whole new synthesis is involved.

As engineering and chemical specialty materials, the silicones have been successful in creating new markets and making inroads in other areas of established potential.

Silicones are being exploited to varying degrees in almost all of the space programs to date—either in the flying hardware or in the lab and production base supporting the more spectacular operational functions.

Silicones find their way into applications through one or more of their innate characteristics—resistance to high temperatures (400° to 600°F), retention of flexibility at low temperatures, resistance to deterioration by light, moisture and ozone as well as heat, and a retention of electrical properties. These are coupled with an incompatibility with most organic compounds and a host of unusual surface properties.

But all silicones do not have all these attributes—it depends on the reactant groups on the Si-O-Si chain and several other factors. Thus silicones often suffer as a family because of the performance of one of the relatives.

● **RTV shielding**—Dow Corning 325 is a silicone rubber—albeit a modified one. Its basic structure is the Si-O-Si skeleton. Since the silicone atom is analagous to the carbon atom, there is the ability to bond to two other groups in each section of the skeleton.

Silicone fluids have relatively short chains of such groups—a few hundred per molecule. But the rubbers have similar chains numbering in hundreds of thousands of such groups per molecule and the molecules are almost entirely linear.

These molecules are the gum bases of silicone rubbers. The physical characteristics of the rubbers—in addition to the basic silicone structure groupings —are achieved through fillers and curing agents.

For example, a fundamental gum would be the Si-O-Si chain with methyl groups positioned on the two remaining active sites on each silicon atom. Vulcanization is simply the joining of these chains at widely separated points along the linear molecules, and this is the function of a curing agent or catalyst. The basic chains are randomly coiled between these junctures, and permit high degrees of extension on a microscopic basis through bond rotation.

Since the elastomeric function or "rubbery" characteristic is achieved by the molecular flow of chain past chain and the crosslinking is relatively weak, the total tensile strength is low. Fillers are used to impede this motion and thus contribute to the tensile strength.

In the case of a silicone rubber used as insulation rather than in a load-bearing function, the filler can contribute enormously to the insulative mechanism. Dow Corning does not identify the fillers in DC 325, but the carbonaceous char formation and the retention of the heat-formed surface are complex functions of the relationship between the fillers used and the basic silicon chain cross-linking structure. In addition, DC 325 cures at room temperatures and its structure differs from conventional silicone rubber.

● **Fluorosilicones**—The next major silicone area at Dow Corning involves fluorosilicones. These materials are solvent-resistant and similar to their organic cousins—except that the silicones are useful to much lower temperatures. The sealants are resistant to most major fuels—including the hydrazine compounds—and LOX.

Fluorosilicones are, again, a family of materials. The essential change is the addition of fluorine groups to the active sites along the Si-O-Si linkage. The types of groups and lengths of chains determine chemical and physical properties of the specific material. ■

Circle No. 6 on Subscriber Service Card.

GT-5 Astronaut Will Leave Capsule

Extravehicular exploration will begin with GT-4, is intended to evaluate man's ability to perform useful tasks in space

EXTRAVEHICULAR FLIGHT experiments call for Project *Gemini* astronauts to spend up to an hour outside their spacecraft with a rocket strapped on their backs while maneuvering through space.

The test program was prepared under a joint NASA/DOD agreement. It will begin on the fourth *Gemini* flight when an astronaut will simply open the hatch, stand up and peer through space. First step out into space will be made on the fifth flight, and then the periods outside the spacecraft will be gradually lengthened in later missions.

The extravehicular program, according to Reginald M. Machell of the Manned Spacecraft Center's Gemini Project Office, is designed to:

—Evaluate man's capability to perform useful tasks in space.

—Extend the capability of the *Gemini* spacecraft by making it possible to carry additional equipment in the spacecraft adapter or stow special equipment in the *Agena* target vehicle, which the astronaut could retrieve extravehicularly.

—Provide a capability to evaluate advanced extravehicular equipment in support of the manned spaceflight program.

The first attempt on *GT-4* may be of "up through 10 minutes" duration with the hatch open.

After performing safety checks of the spacecraft and space suit systems, astronauts will pressurize their suits, depressurize the spacecraft. Then one astronaut will open the hatch, stand up and look out. He will be tethered to the spacecraft on a short line, probably attached to a "D" ring on his restraint harness.

An astronaut will venture out of the capsule into space possibly during *GT-5* Machell said. He probably will be attached to the spacecraft on a short tether as before, but use of a longer tether, from 20 to 25 ft., is being studied.

His purpose will be to conduct an external inspection of the spacecraft. Machell said hand holds may be permanently affixed to the afterbody or may be a plug-in/pull-out type.

● **Gradual extensions**—The time outside the spacecraft will be extended "up through 30 minutes" on *GT-6* and following flights through *GT-9,* Machell said.

On these flights the astronaut will egress completely and move to the equipment section of the adapter. He may retrieve equipment, or a collection plate for an experiment, or may perform the exercise "just to see if it can be done."

On following flights, in a gradual buildup of confidence, the astronaut may evaluate torqueless tools, conduct experiments, affix or retrieve data packages. Under consideration is retrieval of equipment from the *Agena* target vehicle after the spacecraft docks with it in space.

The final three *Gemini* missions may include periods "up through one hour" outside the spacecraft. Machell said advanced extravehicular equipment may be evaluated provided life support packs are developed to accommodate the astronaut for the longer periods.

● **Backpack**—A self-stabilized maneuvering unit worn on the astronaut's back and designed for operation within a 2,000-ft. radius of the spacecraft may be evaluated on the last two *Gemini* missions.

The astronaut will test the device first while he is tethered to the spacecraft, and on a later mission, while he is free and clear of the spacecraft.

A 12-thruster arrangement in the back pack will give the astronaut five degrees of motion—three in rotation and two in translation.

Captain E. G. Givens, Jr., Air Force Systems Command project officer assigned to the DOD/Gemini group at the Manned Spacecraft Center, said the astronaut can achieve lateral translation by rotating himself with yaw control, then applying the forward thruster.

The Aeronautical Systems Division of the Air Force Systems Command, under the technical direction of P. N. Van Schaik, plans to let a contract soon for the design and fabrication of the backpack. Some unresolved problems will be left for the contractor to work out, Givens said.

The unit will weigh approximately 156 lbs. Dimensions may vary, but specifications now call for a back pack 32 inches long, 23 inches wide, and 11 inches thick.

Eight hydrogen peroxide thrusters will be located at the corners of the rectangular pack. The four forward-firing thrusters will extend five inches beyond the pack to clear the astronaut's body. These eight thrusters provide fore and aft translation, pitch and yaw control.

Two upward-firing thrusters, and two downward-firing thrusters provide vertical translation, and roll control.

The maneuvering unit is automatically stabilized using integrating rate gyros as sensors. These hold the pilot stable within plus or minus 5 degrees except when a change in attitude is being commanded. Rates across the deadband do not exceed one-third of a degree per second.

Total impulse of the unit will be between 3,000 and 3,500 pound-seconds.

Using two hands, the astronaut will control the maneuvering unit from a "console" located across the front and near the bottom of a chest pack. Recessed to the right may be a four-position toggle switch for translational control operated by the right hand. In the center may be two other controls: a two-position toggle switch for roll, and a four-position toggle switch for pitch and yaw. All of the switches will probably be spring-loaded to "center-off" position.

Details of hook-up between the chest

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pack and the back pack will be resolved by the contractor.

Tethered, the astronaut will tap the main spacecraft supply of oxygen through the umbilical, which also contains communications and telemetry lines. Untethered, he will draw his oxygen from a 5.84-lb. oxygen supply contained in the back pack, giving him one hour's total capability. A 4.6-lb. emergency supply, located in the chest pack, will give the astronaut another 20 to 30 minutes of oxygen.

● **Monopropellant propulsion**—Hydrogen peroxide for back pack propulsion is storable up to 10 days in an insulated container pressurized to forestall decomposition.

During check-out, the astronaut will open the valve from the container to fill the thruster lines with fuel, and also to release any trapped gases into space.

He will carry a "check-out" box, either from the spacecraft cockpit or will detach it from the maneuvering unit in the adapter to evaluate fuel and oxygen pressures, to check battery power, and the general status of the unit prior to donning the back pack.

A telemetering system in the back pack will relay 60 items of information, including bioinstrumentation data, to the spacecraft on-board recorder.

Tests for evaluating the unit "piecemeal" will be conducted in a KC-135 aircraft. Compressed nitrogen cold gas (for safety in the aircraft) will be used in the thrusters.

Extensive exhaust plume analysis tests using hydrogen peroxide in the thrusters will be made in environmental chambers at the Arnold Engineering Development Center and in the contractor's plant. This information will be used to design protection into the astronaut's suit, especially over the hand and arm areas. Givens said they anticipate no significant problems with thruster plume impingement on the spacecraft.

The spacecraft thrusters will be shut down during all extravehicular activity except in extreme emergency.

● **Disembarking**—The 1,100 cubic-inch chest pack, weighing 45 lbs. and stowed in the overhead center compartment normally reserved for the 14-day food box, will be checked out and donned in the spacecraft.

After the spacecraft is depressurized, and systems verified, the astronaut will open the hatch, unstrap his harness, stand up and climb out.

He will make his way to the adapter section where the back pack unit will be stored in the area occupied by the rendezvous evaluation pod on earlier missions. It will be fastened on a "guillotine" base. After he checks out the unit, he will slip into its harness. The "guillotine" will cut him loose from the adapter. Still tethered to the spacecraft, the astronaut will push himself to a safe distance to begin evaluation maneuvers.

Depending on demands made on the thrusters, the evaluation mission will last from 40 to 45 minutes. The life support system will be the "pacing item."

For obvious reasons of safety during exploratory testing, the Air Force is purposely designing a "high degree of sophistication into the unit," Givens said. "The second step may be toward simplification." He added that evaluation in space will give them the needed "psychological factor" that cannot be simulated in tests on the ground.

No single point failure in the unit will jeopardize the man's life, although it may terminate the mission. He explained that as many as six thrusters can fail, and depending on his fuel supply, the astronaut can get back to the spacecraft although at reduced acceleratoin.

● **The suit**—The extravehicular suit is a modified *Gemini* suit serving as the primary life support system after the astronaut leaves the spacecraft. It uses the single-wall, pressure vessel concept employed through the *Apollo* suit only in leak-susceptible areas. For example, a layer of material is used as a pressure guard behind the main zipper.

An "over visor" is being designed to "back up" the single layer helmet visor and to protect the astronaut's eyes from ultra-violet rays.

Temperatures on the spacecraft skin during *Mercury* flights showed a range from —50° to 250° F. The astronaut's hand, knees, and feet as he traverses the spacecraft will be protected by heavily padded mittens, knee pads and boots. For missions up to one hour, a thermal garment will maintain thermal equilibrium and protect the astronaut from micrometeoroid penetration.

The longer he stays outside the spacecraft, the greater the probability he will be hit by micrometeoroids. MSC is looking into padding using soft goods for the "overgarment" since using metal would deter mobility. It is still undecided whether the coverall will be part of the suit or a separate garment.

A semi-open-loop oxygen flow system is being proposed for early extravehicular activity, but an advanced life support system with greater heat dissipation capability will have to be designed for longer missions.

An ejector pump in the chest pack will circulate the oxygen. A portion of the oxygen will be dumped overboard. Another portion of the oxygen will be recirculated through the system. A sensor in the flow control valve will monitor the carbon dioxide level and will actuate the "dump" valve. A water boiler in the recirculated portion of the loop will dissipate the heat. ■



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Northrop's T-38 and F-5 family of supersonic trainers and tactical fighters are designed so evei thing that needs maintaining is easy to get at. Th means that the systems and subsystems are easy install in the first place.

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Men can work over, around and under the fus lages in natural positions without getting in eac



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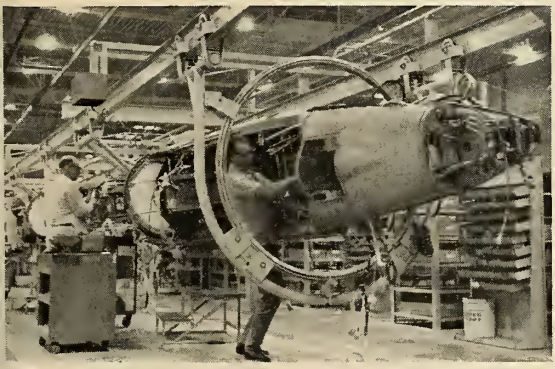
Two men move a fuselage to the next station.



At left are final assembly lines for T-38 and F-5. Forward fuselage lines are at right. Overhead-rail lines total 1,690 feet, with 50 work stations.

other's way. That's because the fuselages hang from elevated rails instead of resting on dollies. Sides of the fuselages are at natural standing height. Bottoms are far enough off the floor so men can work under them comfortably seated. The rails support platforms for work on top.

When the time comes for the lines to move, two men push each fuselage to the next station. The floor doesn't have to be cleared—it's clear anyway because all utility outlets are 7 feet off the floor in the rail structure. No clutter of cables and hoses on the floor. No dirt and junk to sweep out of tracks.



The easy way to install cockpit systems. Forward fuselages rotate 360° in trunnions.

Parts and tools are near workers on both levels. No long walks, no waits.

Before they're mated to the center fuselages the forward fuselages have overhead-rail lines of their own. Here the cockpit sections hang in trunnions so they can be turned on their sides. Instead of standing on his head to work in a cockpit, a man stands comfortably on his feet. Another, standing across from him, installs systems in the belly.

Military aircraft have become sophisticated weapons systems. Most of them are so complicated, and production runs are so short, that it's not practical to apply volume techniques.

The T-38 and F-5, however, belong to a new generation. Their design carries sophistication to its logical end: simplicity. They deliver outstanding performance, yet they're simple to fly, simple to support and maintain. And with Northrop innovations in volume production techniques, they're simple to manufacture, too.

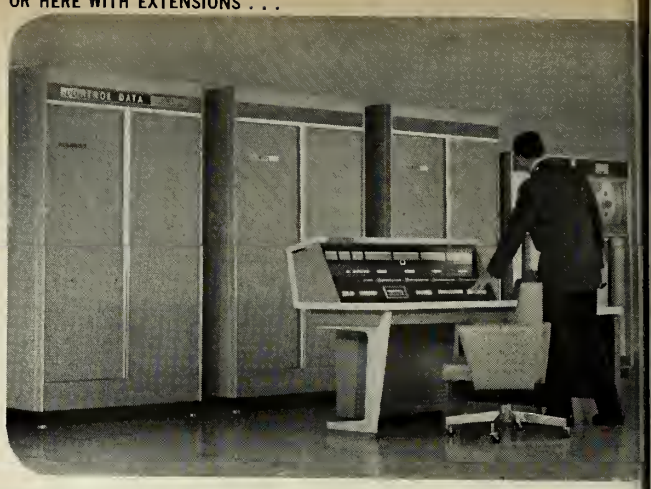
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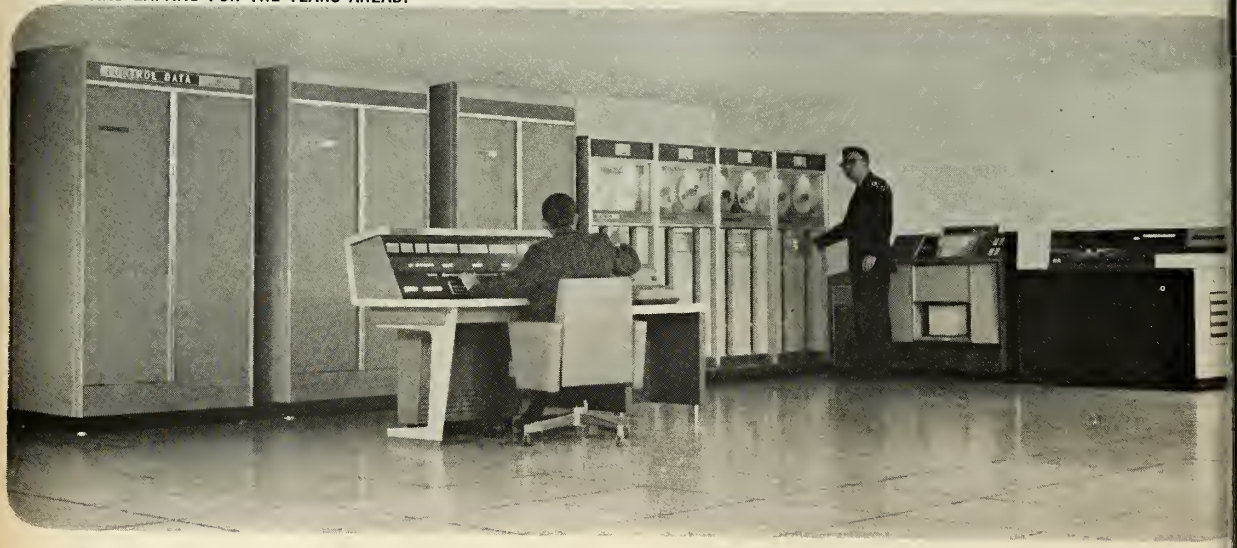
START HERE WITH A BASIC SYSTEM . . .



OR HERE WITH EXTENSIONS . . .



OR HERE AND EXPAND FOR THE YEARS AHEAD.



THE CONTROL DATA® 160G ANSWERS YOUR QUESTIONS ABOUT COMPUTER SIZE AND COMPUTING ECONOMY

Here is how the **CONTROL DATA 160G** Computing System answers some of the most pressing questions about computer size and computing economy:

How much computing power do you need to handle your present data processing operations?

Depending on the scale of problems to be solved, you can select, by modules, the exact size 160G system you need—according to computing capacity, memory size and input-output arrangement.

How about system growth to accommodate your problem growth?

Complete modularity of the **CONTROL DATA 160G** makes available required system capability whenever you need it—as many as nine compute modules can access one memory module; magnetic core storage is expandable from 8,192 to 131,072 words with 1.35 microsecond cycle time; you can expand input-output data channels on one compute module to give you seven buffered channels and one non-buffered.

How can you maintain a high rate of computations-per-dollar with an expanded 160G system?

Expansion of the 160G is economical, does not interrupt the operation of an existing system and requires minimum rearrangement of your site environment. Also, an existing **CONTROL DATA 160-A** system can be upgraded in computing capacity without the retraining or reprogramming required when a totally different system replaces one in service.

If yours is a "new use" problem, system replacement or system expansion, investigate the advantages of the **CONTROL DATA 160G,** which fully utilizes all of the field-proven 160-A programming packages. Contact your nearest Control Data representative.

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Mergers and Acquisitions

Boards of Directors of McCormick Selph Assoc. and Teledyne, Inc., have agreed, pending final approval by McCormick Selph stockholders, to merge the two firms. Merger would involve the exchange of one share of Teledyne common for six of McCormick Selph. Teledyne, Hawthorne, Calif., produces a line of electronic, electromechanical and hydraulic systems and components; McCormick Selph, Hollister, Calif., develops and manufactures explosive ordnance systems and components. . . . *Stockholders of Fairbanks Whitney Corp., New York City, have approved the total acquisition by that corporation of its Fairbanks Morse subsidiary and change of the parent firm's name to Colt Industries, Inc.* . . . LCR Electronics, Inc., a newly formed company in Horseheads, N.Y., has purchased the assets of the Corning Glass Works metallized glass electronics products business. Corning sold the line in order to concentrate more on its "mainstream" electronics products. . . . *Waltham Precision Instrument Co., Waltham, Mass., has purchased Glasseal Products Co., Linden, N.J. Glasseal manufactures glass-to-metal and ceramic-to-metal vacuum seals and related products. It will continue to operate from its present facilities under present management.* . . . Kellett Aircraft Corp., Willow Grove, Pa., has acquired exclusive manufacturing rights to spares and related hardware for all commercial radar systems designed and formerly made by the Special Products Div. of ITE Circuit Breaker Co., Philadelphia.

New Firms and Divisions

Telecomputing Corp., Los Angeles, has changed its name to Whittaker Corp. Reason given for the change is that the old name implied a scope of activities more limited than those the firm is now active in. New electronics activities undertaken by the Whittaker Corp. include manufacture of solid-state and video switching systems as well as marketing of the British-made EMI television cameras, video tape, photo multiplier tubes and klystrons in the U.S. . . . *Simpson Electric Co., Chicago, has formed the Western Div. in Escondido, Calif. The new division now manufactures the firm's panel meters, expanded scale meters, and meter analyzers.*

International

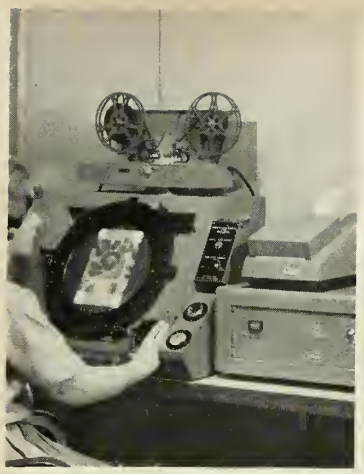
Perkin-Elmer Corp., Norwalk, Conn., has signed a license option agreement with Elliott Brothers Ltd., London, naming EB as exclusive agent for sale of the Vernistat line of high-precision ac potentiometers and adjustable function generators in the United Kingdom and all Commonwealth countries except Canada. EB also has been granted rights to manufacture the same products in the United Kingdom. Among the missile systems using the Vernistat are *Polaris, Titan* and *Subroc*. . . . *Harrison Manufacturing Co., Burbank, Calif., has appointed Spear International of Frankfurt, Germany, to represent that company as marketing and sales consultants in the European Common Market countries. Harrison specializes in missile and aircraft plumbing systems under the trade names of K-Seals and Astroweight.* . . . Webber Manufacturing Co., Inc., Indianapolis, Ind., has appointed Nippon S. T. Johnson Sales Co. Ltd., Tokyo, exclusive agents in Japan for its environmental chambers. . . . *Alpha Microwave, Inc., Newton, Mass., has appointed Microwave International Corp., New York City, as exclusive export agents to handle sales in all foreign countries except Canada.*

Industry Facilities

McLean Laboratories, Princeton Junction, N.J., has broken ground on a 50% expansion of its present 25,000-sq.-ft. manufacturing facility. McLean manufactures electronics cooling systems for missile/space and other applications. . . . *California Institute of Technology Jet Propulsion Laboratories has dedicated a new three-story Space Flight Operation Facility in Pasadena for the conduct of all JPL space flight operations. Bendix Field Engineering Corp. will assist JPL in operation and maintenance of the facility.* . . . Indiana University has announced a plan to make available to member companies of its Aerospace Research Applications Center portions of a 62-acre tract on the north edge of the campus on an option-to-buy basis. ARAC is designed to offer member companies "ready access to the broad scientific and technological advances that are being made by the National Aeronautics and Space Administration and other Government research and development programs." . . . *Sylvania Electric Products, Inc., has completed construction of a test facility in Waltham, Mass., to evaluate performance of the ground electronics system that controls readiness, targeting and launching of Minuteman ICBM's. The facility duplicates a launch control center and a missile launch facility.*

Company Representatives

Fairchild Du Mont Laboratories, Clifton, N.J., has appointed Dannemiller-Smith, Inc., of Dallas, Houston and New Orleans field engineering representatives for its oscilloscopes and other scientific instruments. . . . *United Control Corp., Redmond, Wash., has named Airsupply Co., a division for the Garrett Corp., as engineering sales representatives.* . . . Kings Electronics Co., Inc., Tuckahoe, N.Y., has appointed Engineering Supply Co., a division of Texas Instruments, as a stocking distributor for the New England States and the Southwest. . . . *The Diehl Div. of the Singer Co., Somerville, N.J., has named Hamilton, Grayden & Flemmer, Inc., Hopkins, Minn., as sales representatives for the Minneapolis area. The Diehl Div. manufactures servo components, commercial and military motors, electronic products and cooling devices.*



Vanguard Motion Analyzer shown with Coleman digitizing equipment and Clary printer. A wide choice of automatic readout/printout equipment is available to cut data-reduction time and improve accuracy.

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contracts and procurements

AWARDS

AIR FORCE

$5,435,149—**Hughes Aircraft Corp.,** Culver City, Calif., for continued production of test equipment for missile inertial guidance systems.

$5,100,000—**Sylvania Electric Products, Inc.,** New York, for continued development of a ground electronics system to provide command and control functions for the *Minuteman* ICBM weapon system.

$4,100,000—**Harnischfeger Corp.,** Milwaukee, Wis., for 66 truck cranes for use at tbe *Minuteman* missile base in Grand Forks, N.D.

$3,900,000—**The Boeing Co.,** Wichita, Kan., for further work on the *Minuteman* ICBM system.

$3,700,000—**International Telephone & Telegraph Corp.,** Clifton, N.J., for production of electronic components.

$3,493,383—**Lockheed Aircraft Co.,** Sunnyvale, Calif., for continued work on the *Agena* booster system.

$3,100,000—**Thiokol Chemical Corp.,** Bristol, Pa., for follow-on production of Stage 1 motors for the *Minuteman* ICBM.

$1,800,000—**Atlantic Research Corp.,** Alexandria, Va., for *Arcas* meteorological rockets for use by all three services.

$1,500,000—**Dow Chemical Corp.,** Midland, Mich., for evaluation of solid propellants.

$1,000,000—**General Dynamics Corp.,** San Diego, Calif., for continued work on *Atlas* space boosters.

$370,000—**United Technology Center,** Sunnyvale, Calif., for study and laboratory tests of various methods of thrust variation by propellant flow control.

$357,399—**Vitro Corp. of America,** Vitro Laboratories Div., West Orange, N.J., for a high-resolution tracker.

$140,210—**MHD Research, Inc.,** Newport Beach, Calif., for a study of high-energy storable propellant concepts.

$88,396—**Atlantic Research Corp.,** Alexandria, Va., for a study of pyrolytic graphite-coated nozzles.

$50,000—**National Research Corp.,** Cambridge, Mass., for development of encapsulated ingredients for solid propellants.

$25,080—**Motorola, Inc.,** Scottsdale, Ariz., for C-band transponders.

Ling-Temco-Vought, Inc., Dallas, for investigation of mechanical properties of three metal alloys for possible use in cryogenic applications (amount undisclosed).

ARMY

$2,500,000—**Honeywell Co.,** Minneapolis, Minn., for classified electronics equipment.

$1,540,657—**Monsanto Research Corp.,** Dayton, Ohio, for unspecified research services.

$1,300,000—**Hayes International Corp.,** Birmingham, Ala., for *Sergeant* missile launchers.

$1,012,800—**H. J. High Construction Co.,** Orlando, Fla., for additional construction on the Operations and Checkout Building at the Merritt Island Launch Area.

$1,000,000—**ITT General Controls, Inc.,** Glendale, Calif., for control valves for use on *Saturn* missile test pads at the NASA test facility in Hancock County, Miss.

$735,854—**Georgia Electric Co.,** Albany, Ga., for additional roads and utilities at the Merritt Island Launch Area.

$200,800—**General Dynamics Corp.,** General Atomic Div., San Diego, Calif., for research on hypervelocity impact.

$80,670—**Operations Research, Inc.,** Silver Spring, Md., for evaluation study of the relative effectiveness of Army medical systems.

NAVY

$7,145,700—**Bendix Corp.,** Oxnard, Calif., for operation and maintenance of instrumentation systems at the Pacific Missile Range.

$3,000,000—**General Precision, Inc.,** Glendale, Calif., for fire-control systems related to the *Subroc* missile system.

$3,000,000—**Control Data Corp.,** Minneapolis, Minn., for the *Polaris* Target Card Computing System (PTCCS).

$2,800,000—**Sperry Rand Corp.,** Bristol, Tenn., for target detecting equipment related to the *Tartar* and *Terrier* missile systems.

$2,400,000—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., for further work on rocket motors for the *Shrike* and *Sparrow III* missile systems.

$1,329,999—**Honeywell Co.,** Minneapolis, Minn., for components of autopilot systems.

$150,000—**Hughes Aircraft Co.,** Culver City, Calif., for radar guidance for surface-launched missiles.

Kaiser Engineers, Oakland, Calif., for the design of a two-position vertical test facility for the *Saturn* S-II stage (amount undisclosed).

NASA

$4,500,000—**Hayes International Corp.,** Birmingham, Ala., for five contract modifications covering fabrication and engineering services for the next six months at Marshall Space Flight Center.

$149,989—**Carco Electronics,** Menlo Park, Calif., for a three-axis rate table.

$129,000—**Motorola, Inc.,** Scottsdale, Ariz., for tests on the unified S-band communications equipment for Project *Apollo*.

$35,740—**Simmonds Precision Products, Inc.,** Tarrytown, N.Y., for *Gemini* UHF training beacons.

$34,265—**Hewlett Packard Co.,** Palo Alto, Calif., for a time interval meter.

$31,697—**Tektronix, Inc.,** Palo Alto, Calif., for oscilloscopes.

$26,172—**Statham Instruments, Inc.,** Los Angeles, for a linear accelerometer.

Oak Ridge Institute of Nuclear Studies, Medical Div., Oak Ridge, Tenn., for a study of radiation problems that may be encountered in manned space flight (amount undisclosed).

INDUSTRY

$4,900,000—**Marquardt Corp.,** Van Nuys, Calif., from **Aerojet-General Corp.,** El Monte, Calif., for production of rocket nozzles for the *Polaris A-3* missile system.

$100,000—**Pacific Automation Products,** Glendale, Calif., from **North American Aviation, Inc.,** Space & Infomation Systems Div., Downey, Calif., for electronic cabling systems related to the support of *Saturn* and *Apollo* programs.

$70,000—**On Mark Couplings,** Los Angeles, from **United Technology Center,** Sunnyvale, Calif., for development and production of balanced valve couplings for the *Titan III-C* booster.

Microwave Associates, Inc., Burlington, Mass., from **Sylvania Electric Products, Inc.,** Electronic Systems Div., Waltham, Mass., for a waveguide feed system for use in the *Nike-X* Multi-function Array Radar (MAR) (amount undisclosed).

International Microwave Corp., Cos Cob, Conn., from **Radio Corp. of America,** New York, for tunnel diode amplifiers to be used in RCA's solid-state microwave relay system in future commercial communications (amount undisclosed).

Leach Corp., Control Div., Azusa, Calif., from **RCA**, Astro-Electronics Div., Princeton, N.J., for procurement of five-watt VHF-FM telemetry transmitters for use in the *Tiros* meteorological satellite (amount undisclosed).

Ferro Corp., Goldsworthy Engineering Div., Norwalk, Conn., from **Thiokol Chemical Corp.**, Alpba Div., Huntsville, Ala., for design and fabrication of a filament winding machine (amount undisclosed).

Goodyear Tire & Rubber Co., Akron, Ohio, from **American Machine & Foundry Co.**, Stamford, Conn., for production of extra-wide tires and wheels for *Saturn* missile carriers (amount undisclosed).

American Bosch Arma Corp., Arma Div., Garden City, N.Y., and Tele-Dynamics Div., Philadelphia, from **Ling-Temco-Vought, Inc.**, Dallas, for gyroscopes and telemetry components for the *Lance* tactical missile system (amount undisclosed).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland
Attn.: Contracting Officer, Code 248

Portable automatic calibration tracker. Preference will be given proposals submitted by offerers with past experience and proven capabilities in the field. RFP-PCN 66803 due 6/1/64.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

Technical study entitled Interplanetary Mission Support Requirements. Purpose is to identify technological steps which must be taken prior to manned planetary flights. RFP MSC 64-1284P due 5/28/64.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

Negotiations will be conducted with Westinghouse Electric Corp. Research Laboratories, Pittsburgh, to develop a scan converter system to be used in the study and evaluation of the *Apollo* LEM television system. RFP MSC 64-1309P not available. For information only.

Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Negotiations will be conducted with Westinghouse Electric Corp., Lima, Ohio, for a study effort of power conditioning for thermionic electric power sources. Relative to efforts conducted under contract NAS5-1234. RFP SPSD-1188 not available. For information only.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

Study of lunar atmosphere detection and monitoring system. For astronaut use in Lunar Orbit I study. RFP MSC 64-1224P due 5/28/64.

USAMICOM
Redstone Arsenal, Alabama
Attn.: Directorate of Procurement and Production

Research and development effort for the design and fabrication of a *Redeye* handling trainer. Negotiations will be conducted with General Dynamics/Pomona, Pomona, Calif. Inquiries relative to subcontracting should be referred to the above contractor.

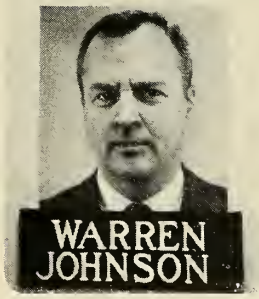


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M/R



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CLARY

Clary Corporation

MILITARY PRODUCTS DIVISION

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Circle No. 11 on Subscriber Service Card



New Product of the Week:

Spectrum Signature Adaptor

Singer Co.'s Metrics Div. is marketing a spectrum signature adaptor especially designed for use with presently available RFI and noise and field intensity meters.

The Model PA-210 displays on a CRT the amplitude versus frequency spectrograph of a selected band as determined by the RFI instrument with which it is used. Spectrum segments up to 10 times the IF bandwidth of the meter can be studied. The device has four tuning heads, which function with IF's of 225 kc, 455 kc, 1.6, 10.7, 30, 42 and 60 mc, 140 mc and 160 mc.

Circle No. 151 on Subscriber Service Card

200-Watt AC Source

Optimation, Inc., has available a laboratory ac source that will deliver up to 200 watts ±1 db over a frequency range from 20 to 20,000 cps.

The Model AC-101 provides voltages to 1,500v RMS and currents to 20 amps RMS, selectable by an eight-position voltage/current range switch and an amplitude control with 0.002% resolution. Amplitude instability is maintained below 0.01% for 5 to 10-minute periods. Distortion is less than 0.1% at 200 watts output. An optional ratio transformer allows selection of precise amplitude ratio increments from 0.0000 to 1.1111.

Circle No. 152 on Subscriber Service Card

FM Telemetry Transmitter

A 2-watt transistorized FM telemetry transmitter operating on a telemery band of 215 to 265 mc is available from Leach Corp.

Designated the FM 200, the solid-state device has an RF stability held to within 0.01% of the assigned center frequency under all specified environments and a temperature variation of −20° to 85° C. It can withstand shock and acceleration to 100 g's and vibration to 20 g's at 2,000 cps. Spurious frequencies are eliminated through use of an amplifier in the final power stage. Input requirement is 655 ma (maximum) of 28v dc power.

Circle No. 153 on Subscriber Service Card

Spectrum Analyzer

A portable spectrum analyzer that draws only 40 watts of power has been developed by Pentrix Corp.

The Model S-64, weighing less than 35 lbs., covers the 10-mc to 40-gc frequency range. Employing a persistent, 3½-in. square CRT, the analyzer can display log (40 db), linear (26 db), or square law (13 db) as the dynamic range.

Dispersion is continuously variable between 10 kc and 5 mc on one switch



position and between 1 mc and 60 mc on the other. Resolution bandwidth (3 db) is 1 kc to 100 kc, also variable. Sweeprate may be adjusted from below 1 to 100 cps.

Circle No. 154 on Subscriber Service Card

Digital Sequencer

Consolidated Systems Corp. has developed a programmable digital sequencer capable of operating each of 50 or more events at any millisecond within a two-hour period.

The system is designed to be used wherever a predetermined sequence of events is to take place at precisely timed intervals. A crystal-controlled oscillator provides the time base. Programming is accomplished by inserting diode pins in a pinboard. A reversible counter provides timing and digital clock readout.

Circle No. 155 on Subscriber Service Card

Environmental Recorder

A subminiature, hermetically sealed tape transport for high environmental applications, such as sounding rockets, nuclear tests and rocket sleds, has been developed by the Leach Corp.

The MTR 400 has a 150-ft. tape capacity with two interlaced recording heads on 1.5-in. centers for IRIG compatibility. At 15 ips, the unit has a recording time of 2 min.; however, many recording speeds are available.



The system offers 7, 14 and 16-channel recording with flutter varying from less than 1% p/p under no environment to 12% p/p under shock environments of 750 g's. The unit is operational through 2,000 g's. Vibration is 10 g's to 2,000 cps and 20 g's to 1,500 cps. Temperature range is —65° to 160°F.

Circle No. 156 on Subscriber Service Card

Electrostatic Chopper

Rawco Instruments, Inc., has developed a multi-million volt electrostatic chopper, said to open the door to a new line of instruments, particularly in the measurement of dc electrostatic field intensity.

The instrument will continuously monitor clouds, clear air masses and other objects to detect electrostatic changes, their intensity and/or rate of change. Models available include an atmospheric monitor, with a range from 0 to millions of volts; a room monitor and a portable monitor, both with a range of 0 to 10,000,000v.

Circle No. 157 on Subscriber Service Card

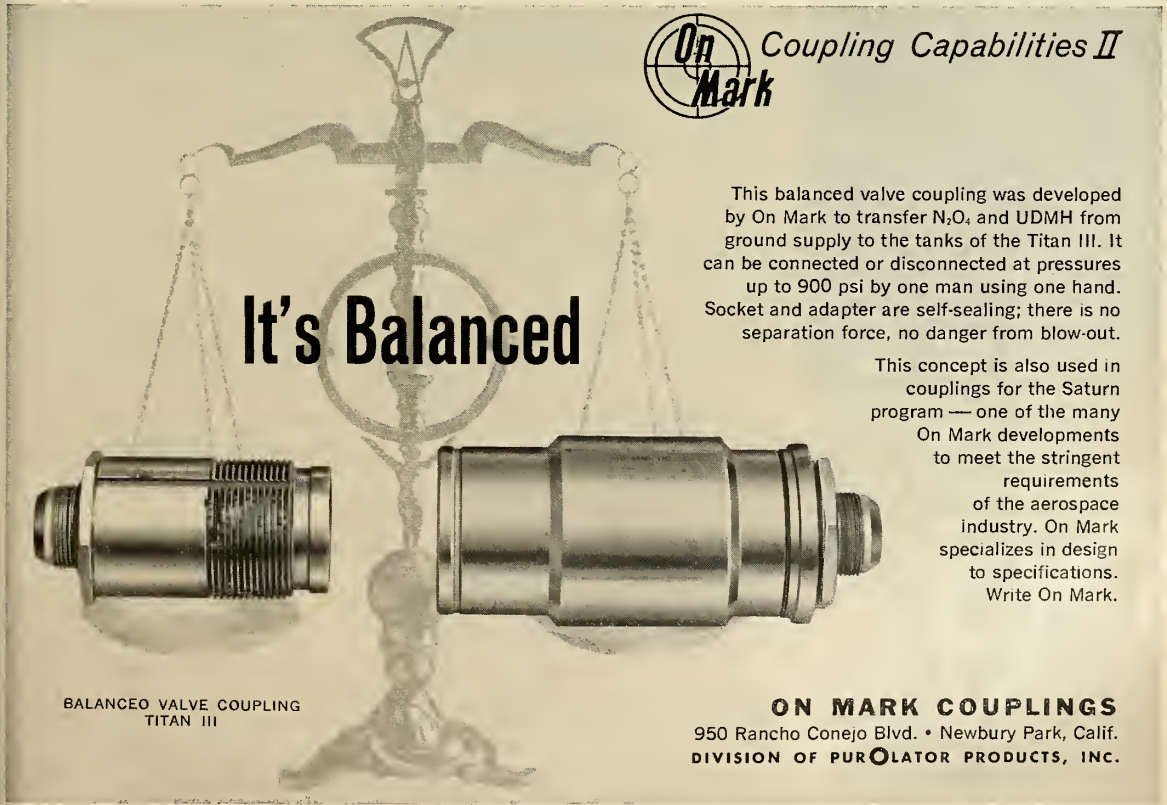
Magnetic Reed Switch

A single-pole, double-throw magnetic reed switch, designed as a normally closed switch that does not require biasing magnets, has been announced by Hamlin, Inc.

The MRG-DT has a maximum glass diameter of 0.13 in. and overall length of 2⅛ in. The 0.625-in. glass length permits cutting of the leads to 0.750 in. maximum length for crystal can type packaging.

Average life expectancy of the unit is 10 x 10^6 operations at a full rating of 3 watts dc resistive, 28v maximum and 0.25 amps maximum. Initial resistance is 150 milliohms; insulation resistance is 100 megohms. The device is available with a ±7½ amp-turn tolerance in the 30 to 80 amp-turn range.

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names in the news



McKENNEY



HILL



ALTMAN



McANDREWS



BRADLEY

J. D. McKenney: Appointed president of Aerolab Development Co., San Marino, Calif.

Joseph F. Price: Joined Fairchild Semiconductor as special representative to government agencies in the Washington, D.C., area.

Francis T. Boyle: Appointed manager of strategic marketing for Hughes Aircraft Co.'s ground systems group, Fullerton, Calif.

Richard N. Sindric: Joined Almay Research & Testing Corp., Los Angeles, as director of technical services.

Harry R. Smith: Elected president of Technical Construction Co., a subsidiary of Ets-Hokin Corp., Compton, Calif.

Robert G. Hill: Named advertising and sales promotion manager for Amplex Corp., Redwood City, Calif.

Duane Sherman: Joined Weston Hydraulics, Ltd., Van Nuys, Calif., as manager of marine sales.

Don Anderson: Joined Hexcel Products, Inc., Berkeley, Calif., as chief design engineer.

Dr. David Altman: Vice president of United Technology Center, Sunnyvale, Calif., selected to receive the AIAA annual Propulsion Award.

Bernard W. Eades: Appointed a senior sales representative for the Electronic Equipment Div. of McDonnell Aircraft, St. Louis, Mo.

Robert J. McAndrews: Appointed vice president-finance for Nuclear Data, Inc., Palatine, Ill.

William F. Bradley: Named director of marketing for Assembly Engineers, Inc., Los Angeles.

William J. Fritton: Elected executive vice president of CONAP, Inc., Allegany, N.Y.

Joseph L. Longoria: Named field sales manager for the nuclear instrument activity of Tracerlab division of Laboratory for Electronics, Inc., Waltham, Mass.

Frederick Walzer: Named operations manager for the Electronic Tube Div. of Du Mont Laboratories divisions of Fairchild Camera and Instrument Corp., Clifton, N.J.

Andrew S. Kariotis: Promoted to vice president-sales and marketing at Alpha Microwave, Inc., Newton, Mass.

Charles M. Dollbaum: Named manager of the liquid hydrogen plant at Union Carbide Corp.'s Linde Div., Sacramento, Calif.

Sanford A. Jaffe: Appointed materiel manager at the Romec Facility, Power Equipment Div., Lear Siegler, Inc., Elyria, Ohio.

Shepherd Sikes: Named national sales manager for aerospace products by U.S. Polymeric Chemicals, Inc., Santa Ana, Calif.

Roy S. Mushrush: Appointed manager of General Electric Co.'s Direct Energy Conversion Operation (DECO), Lynn, Mass.

William J. Kirk: Named commercial products manager of Televiso Electronics Div. of Doughboy Industries, Minneapolis, Minn.

Leo Romberg: Appointed quality control manager for the Industrial Controls Div. of Bendix Corp., Detroit.

Edward Glodeck: Appointed regional manager-NASA for International Telephone and Telegraph Corp.'s Defense and Space Group field marketing organization, Washington, D.C.

Dr. E. M. Baldwin: Named vice president-development engineering for Centralab division of Globe-Union, Inc., Milwaukee.

Charles H. Jackson: Named director of research and development at Space Ordnance Systems, Inc., El Segundo, Calif.

G. E. Laufman: Appointed systems sales manager at Stellarmetrics, Inc., Los Angeles.

Frank V. Genetti: Joined Lockheed Propulsion Co., Redlands, Calif., as large solid motor program manager.

Charles F. Allen: Named manager of the Douglas Missile & Space Systems Div.'s new field office in Boston, Mass.

Eric E. Doorly: Appointed manager of engineering at Solar division of International Harvester Co., San Diego.



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—when and where—

MAY

ASME Fluids Engineering Conference, Bellevue-Stratford Hotel, Philadelphia, May 19-21.

IEEE International Symposium on Microwave Theory and Techniqnes, Kennedy International Airport, May 19-21.

Armed Forces Communications and Electronics Association Annual Convention and Exhibit, Sheraton-Park Hotel, Washington, D.C., May 19-21.

Space and Defense Procurement Briefing Conference, sponsored by Federal Bar Association and Bureau of National Affairs, Sheraton Hotel, Houston, May 20-21.

Seventh National Symposium, "Adhesives and Elastomers for Environmental Extremes," Society of Aerospace Material and Process Engineers, Thunderbird Motel, El Segundo, Calif., May 20-22.

First Annual Symposium of the Subcommittee on Research and Development Contracts, Committee on Government Contracts and Procurement, Federal Bar Association, Waldorf-Astoria Hotel, New York City, May 25.

Aviation/Space Writers Association Annual Conference and News Meeting, Americana Hotel, Bal Harbour, Miami Beach, Fla., May 25-29.

International Electrical Industry Show, New York Coliseum, New York City, May 25-27.

JUNE

National Telemetering Conference, AIAA, IEEE and ISA, Biltmore Hotel, Los Angeles, June 2-4.

National Symposium on Global Communication (GLOBECOM VI), IEEE, University of Pennsylvania and Sheraton Hotel, Philadelphia, June 2-4.

Society of Plastics Engineers Meeting on Stability of Plastics, Sheraton-Park Hotel, Washington, D.C., June 4.

Electromagnetic Window Symposium, sponsored by Atenna Laboratory Dept. of Electrical Engineering, Ohio State University, and Research and Technology Div. USAFSC, Columbus, Ohio, June 2-4.

Symposium on Quasi-Optics, sponsored by Polytechnic Institute of Brooklyn, IEEE, U.S. Army Research Office, U.S. Air Force and U.S. Navy, Statler-Hilton Hotel, New York City, June 8-10.

Systems Engineering Conference and Exposition, New York Coliseum, New York City, June 8-11.

Sixth National Electromagnetic Compatibility Symposium, IEEE, Los Angeles, Calif., June 9-11.

National Electronic Packaging Conference, New York Hilton Hotel, New York City, June 9-11.

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The Bear Trap

"WHAT WE DO or fail to do in space can largely determine our future as a nation."

These words of warning are from Maj. Gen. Osmond J. Ritland, deputy commander for space, Air Force Systems Command, in a recent address in New York City. They come at a particularly appropriate time.

The present improvement in relations with the Soviet Union seems to have removed a sense of urgency from the U.S. military space program, together with other military efforts. We are greatly in favor of the improvement in relations. But we are unalterably opposed to any let-down in military research and development which stems from warped notions about the warmer climate on the international scene.

That climate can turn to freezing overnight. If we meanwhile have allowed U.S. military technology to lag in the ill-begotten belief that time is not critical, we will be in for some rude shocks.

This decaying sense of urgency seems to be coupled with a feeling that we really have the Soviets on the ropes, both militarily and technically. We are back to the old familiar tune that the Russians are a bunch of boobs who don't really know how to run a country and who are incapable of coming up with any significant advances in military science. Recent history already has shown otherwise.

As Gen. Ritland points out, the view was widely held in this country in 1952 that the Soviets had neither the high-priority program nor the technologies needed to exploit the concept of intercontinental ballistic missiles.

Yet by 1954 it was clear that the Russians had not only the technologies but also had a top-priority and well-advanced ICBM program. Meanwhile, the U.S. had lost two years in its own ICBM development and an expensive crash program was required to overtake the Soviet Union.

Well-meaning theoreticians, an economy-talking Administration and naive amateur military analysts are baiting exactly the same trap again in the military space program.

The Pentagon attitude toward *Gemini X* and the *Manned Orbiting Laboratory* is more casual than urgent. Hardly six months have gone by since Secretary of Defense McNamara's announcement of the project. Yet it already is apparent there will be at least a six-month delay in the launch dates he proposed.

We have no quarrel with the Secretary's desire to define the task before letting contracts, but the project is not such a complex or new one that a year's study is necessary in order to reach that point. Let's get on with it. Or must we wait for startling developments from the extensive Soviet space program to jolt us out of our complacency and start us on another tail-chase?

While marking time until arrival of the *MOL* program, the Air Force is not entirely shut out of the manned space effort. Gen. Ritland pointed out that the Air Force Systems Command now is working on 106 tasks for the National Aeronautics and Space Administration. While this is a far from adequate effort—military space tasks should be numbered in the thousands—it nevertheless is interesting to look at just what support USAF is lending to NASA in this regard. Here are some of the examples cited by Gen. Ritland:

The Arnold Engineering Development Center at Tullahoma is carrying out research and development tests on *Gemini* retrorockets, capsule abort systems, ballute devices and other control systems; evaluation of the retrograde system for *Surveyor;* and a range of test activities on *Apollo,* particularly in propulsion.

The Aerospace Medical Division at Brooks AFB is conducting studies of the biological effects of radiation with high-energy protons; investigation of the mechanisms involved in the treatment of radiation sickness; and tests of the possible biophysical effects of prolonged oxygen inhalation.

The new National Range Division is equipped to provide worldwide tracking and communications services to NASA, as well as range safety data reduction and processing and photographic coverage.

There are 262 Air Force officers assigned to NASA. This includes most of NASA's 27 astronauts. NASA has asked for another 55 Air Force officers.

There also are a number of points at which the NASA and Dept. of Defense interests in space are meshed. The highest of these is the policy-making National Aeronautics and Space Council, with both the Secretary of Defense and the NASA Administrator as members.

NOW, TO SOME this may sound like rather extensive Air Force participation in the manned spaceflight program. To us, it is an ineffectual effort, incapable of even providing the base for the extensive military space program which is suddenly going to become imperative one of these days.

Air Force flight experience with its own *Gemini* capsules should be obtained as rapidly as possible, consistent with non-interference in NASA's needs for the *Apollo* program. Considerable experience in military space operations can be gained from *Gemini* far in advance of the *MOL* launch date and can, in fact, be a factor in determining what experiments *MOL* will carry. There is no way of knowing in advance what we will learn in such vital fields as space reconnaissance, satellite interception, or ICBM vulnerability but this information should be sought with the greatest urgency.

Gen. Ritland points out: "The *MOL* program will be carried out in coordination with the National Aeronautics and Space Administration. NASA participation in the *MOL* program is designed to make maximum use of national resources and to insure maximum benefit to NASA from *MOL* experiments, in furtherance of the cooperative efforts in the national space program."

We would like to see somewhat less worry about coordination with NASA and considerably more concern with staying ahead of the Soviet Union in space technology.

William J. Coughlin



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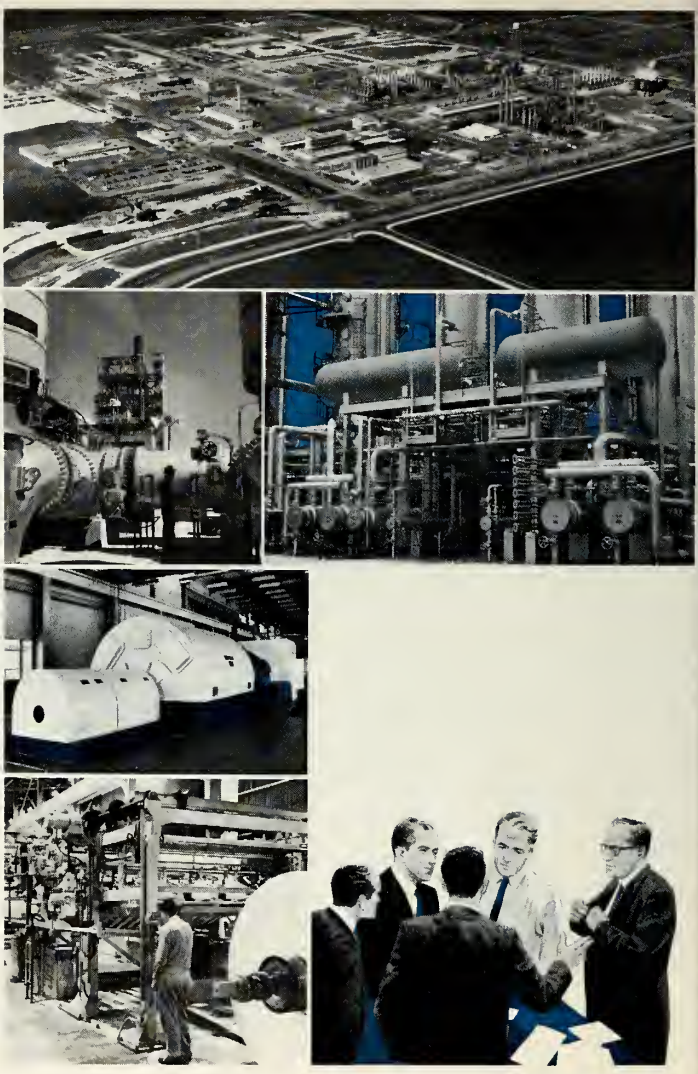
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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



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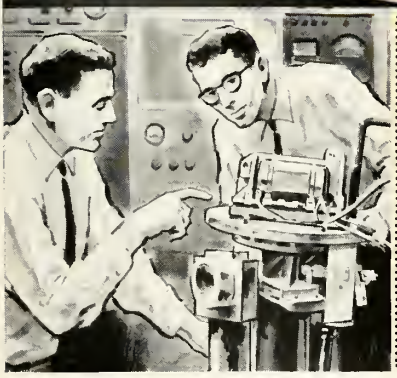
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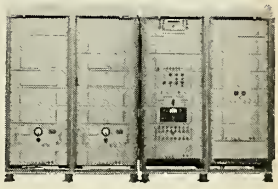
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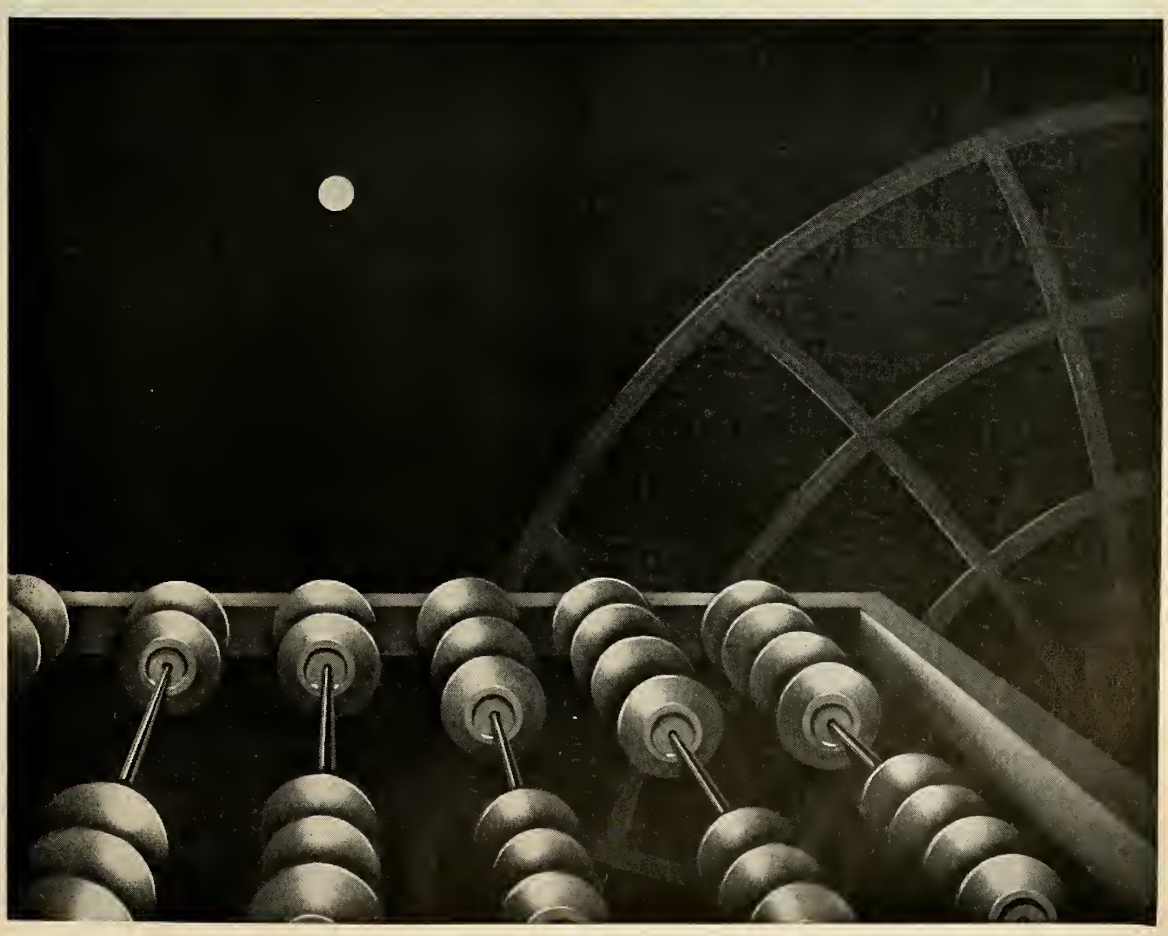
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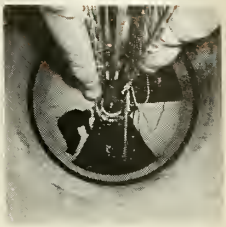
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THE COVER



View from nozzle end of Aerojet-General's 120-in. solid motor case during insulation installation by specialists from Goodyear Tire & Rubber Co. Goodyear is fabricating all insulation for Aerojet's portion of the NASA-AF large solids demonstration program. See story, p. 26.

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Our best customers are very trying people

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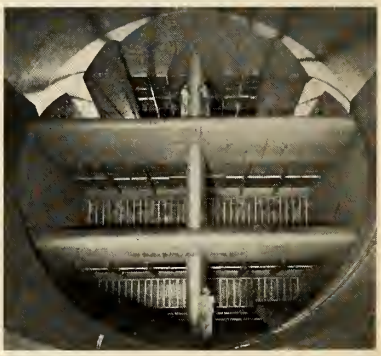
A tunnel so big, a five-story building could sit in its gullet — and a two-lane highway could be built through the steel ducting of its closed-circuit design.

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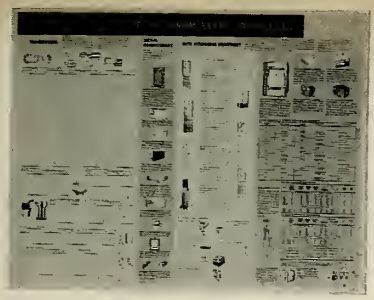


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This chart is for you

Schematically arranged, this CEC chart covers each instrument of data recording equipment in the four primary categories shown below — plus basic specifications, cross-reference tables to aid in selection of instrumentation, and information on how to use *combinations* of the various instruments to meet specific needs. And should you be interested in support equipment for dynamic measuring in industrial or military applications — these important units are included and described as well.

Sensors and Pickups



Chart shows the 43 available for pressure, vibration, acceleration.

Signal Conditioners

Chart shows 11 basic types and where they may be required.





Magnetic Tape

Chart shows 8 analog and digital recorder/reproducers with support equipment.



Direct Readout

Chart shows 5 recording oscillographs, 33 galvanometers and where they can be used. Also support equipment.

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letters

Creative Rights

To the Editor:

I have read with great interest Mr. Miessner's letter on the Celler patents bill (M/R, May 11, p. 4) and am sending copies to U.S. Senators Frank B. Lausche (D-Ohio) and Leverett Saltonstall (R-Mass.).

For a number of years, I too have been trying to convince the U.S. Patents Commissioner and some of our Senators that we need a simpler and less costly system by which the individual inventor (like myself) and the small business can most quickly and cheaply secure some protection for their inventions.

For years, Senator Saltonstall has sought a patents and compensatory system which would be fair to the individual inventor.

You are to be commended for publishing Mr. Miessner's letter.

Russell E. Hollis
New Carlisle, Ohio

Troubled by Speech

To the Editor:

Referring to your description of remarks made by Secretary of Defense McNamara in his speech to the Advertising Council of America (M/R, May 11, p. 8), I hope this man is not serious in what he says.

First: He is concerned about the high cost of an anti-ballistic missile defense system to protect 35% of the U.S. population. I hope I am not among the other 65%.

Second: He predicts that lasers as military weapons, if at all possible, are far in the future. Does this mean that the following news items are "fairy tales?": *New York Times,* March 4, "Army's Laser Rifle Shoots Bursts of Light"; *Philadelphia Bulletin,* March 4, "Deadly Ray Gun Tested at Frankfort Arsenal"; *Newsweek Magazine,* March 16, "Laser Rifle: Army's Hottest Gun."

Third: America's military strength will continue to increase but at a slower rate. Why the slower rate? So Russia can catch up to, or go further ahead of us?

Daniel F. Casey
Jamaica Plain, Mass.

Retirement Proposal

To the Editor:

Most if not all of the companies in the aerospace industries have some type of retirement program. These programs are selling points when the company is recruiting personnel. This is important to many people, especially those interested in remaining with that company. There are many people who benefit from these programs, but many others who do not.

No doubt there are many variations in the programs, but most if not all are based on insurance plans. Wouldn't it benefit individuals, companies, government agencies, and perhaps insurance companies if a Mutual Intercompany Policy were developed? By this I mean that the companies and their insurance companies develop a plan whereby an individual would build retirement benefits in his company that could be transferred to other companies through a central clearing house. An employee of Company A might work six months to X years when circumstances dictate he change companies. If other companies recognized his previous time through some mutual agreement, the man would benefit *and so would the industry*. He would go to Company B with a better feeling towards the companies, and the industry would not lose his talents. Such a program would also be a bargaining point at this time to help stabilize wages. Such a policy should be sponsored and operated by the industry, *not* the government, and it should supplement Social Security, *not* become part of it. Each company could still maintain its own retirement plan. *The Proposed Plan:*

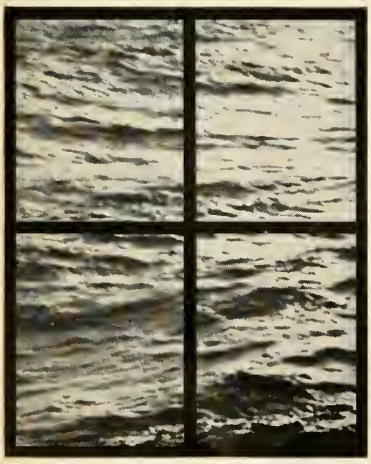
The aforementioned aerospace industries and insurance companies develop a plan similar to money exchanges on foreign money, credit transfer between colleges or the accumulation of credit for military retirement. An individual would receive full credit from his employer if caught in a reduction-in-force action. Perhaps ¾ credit towards company plan if he resigned, and ½ credit if terminated. (It is understood that this could present problems in comparing employees' contribution in time to a company-paid retirement plan. This would be especially true where a man worked three years for Comany A and a minimum of four years is required before a retirement program would have been started.) If an employee passes his probationary period with a company, he should be eligible for the plan.

Another problem would probably be cost—because more people would benefit. The additional cost could well be offset in the first union contract negotiation for each company. One of the factors in demanding salary increases is the insecurity created by the "nature of the business." The industry has progressed because it benefits from past experiences and now has a vast inventory of talents. The government agencies and industry have a huge investment in developing these talents.

Another method of achieving the same end results might be this: Each person who has passed his probationary period be issued an individual policy or plan. On transfer to another company he would take his policy or plan, and the second and succeeding companies then contribute to his plan. The companies would then contribute to his plan an amount equal to that which they would have contributed under their plan. The same policy of partial contribution on separation could still apply as in the first plan.

Harley M. Carpenter
Santa Maria, Calif.

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The Countdown

WASHINGTON

Senators To Measure Saturn Against Titan

The Senate Space Committee is reported to be planning hearings next month to delve into the U.S. launch vehicle stable. Of special interest to the legislators will be the relative merits of the *Titan III* and *Saturn IB* boosters. An Administration official reports, however, that there will be no decision this year to drop either vehicle. This probably means that both will stay in the inventory for some time.

Transtage Problems Explained

Difficulties in the transtage of the *Titan III* are caused by dynamic instability of the fuel flowing into the injector head. Solution to the problem by engine contractor Aerojet-General has been, according to a high-level Air Force officer, "to further complicate the design of an already complicated engine" by introducing baffles around the injector head. Requests for proposals on the back-up transtage are now being evaluated with an eye toward an engine with a simple, straightforward design.

Transit in Use by AMR

The *Transit* navigational satellite—part of the worldwide navigational system—is presently being used at the Atlantic Missile Range as a geodetic aid, Navy officials report.

Kiwi B-4E Next in Rover Test Plans

Next firing in the Project *Rover* ground-test series at Nevada Test Site will be Kiwi B-4E, rather than NRX-A2, as had been reported earlier. B-4E has the same core support and hot-end seal as the B-4D, successfully tested May 13, but has been given some internal improvements. It is currently slated to be the last of the Kiwi reactor series; next will come the Phoebus series, which will uprate the power level.

Gemini Gear Being Tested on the Sea . . .

The tracking ship Rose Knot is now in Chesapeake Bay on a 20-day shakedown cruise during which it will carry out a test program with an instrumented Lockheed Super Constellation aircraft. Equipment on the plane will simulate systems to be used on the *Gemini* and *Agena* in the upcoming two-man spaceflight program.

. . . And in the Air

NASA is now testing the environmental control system for *Gemini* in a series of flights from Wright-Patterson AFB, Ohio. Two test pilots from McDonnell Aircraft are participating in the experiment, which is being run during weightlessness flights with a *Gemini* mockup inside the KC-135 jet.

JPL and La Vie Académique

California Institute of Technology's president Lee A. DuBridge told the House Space Committee that if he were asked now to create the Jet Propulsion Laboratory, he would not do it. While it does contribute to CalTech, he said, it is really a full-blown national science center not essentially related to the university. He added that it was a bit of an administrative burden.

Roosevelt Roads To Be Expanded

The U.S. Naval Station at Roosevelt Roads, Puerto Rico, will be expanded over the next several years to accommodate the eight-fold increase in missile firings expected by 1966. Scheduled shots at the station will climb from the 300 conducted in FY '62 to an expected 2,300 in FY '66.

AF Interest in Tory Flight Renews

Despite earlier reluctance, the Air Force is now reported to be more amenable to flight-testing of the Tory II-C nuclear reactor. The Joint (Congressional) Atomic Energy Committee has been warning that the Pluto program will get the ax if Tory isn't flown, and an AEC Commissioner recently said flatly the program will be phased out because of DOD restrictions on flight-tests (M/R, May 4, p. 16).

INDUSTRY

S-II Stage Eyed as RIFT Substitute

North American Aviation, at the request of NASA's Dr. Wernher von Braun, has prepared a proposed modification of the *Saturn* S-II stage to serve in place of the *RIFT (Reactor in Flight Test)* as a nuclear rocket test vehicle. *RIFT* was to have been built by Lockheed Missile and Space Co., at Moffett Field, Calif. The two designs have the same diameter and their systems are similar, except that no liquid oxygen is required for the nuclear mission. Both stages are designed to carry liquid hydrogen. Some difference in materials would be required to cope with nuclear radiation on the *RIFT* mission.

Apollo S-band Contract Award Nears

NASA expects to select the prime contractor for the *Apollo* project's S-band communications system by the middle of June. The two competing firms are Philco and Collins Radio. The former made its presentation to Goddard Space Flight Center on May 20; the latter will present its bid on May 25.

Extended Apollo Study Bids Awaited

Bids have been requested by June 8 for the second phase of studies of the *Extended Apollo* spacecraft. Contract is expected to be worth about $300,000. Missions to be studied include 15-60-day Earth-orbital flights, lunar orbital flights of one week to three months, and maximum elliptical Earth orbits.

F-1 Qualification Tests Delayed

Flight-rating test for the Rocketdyne F-1 engine has now been delayed until December of this year. Earlier it had been scheduled for the middle of the year. Tests leading up to the qualification will begin in September. Qualification of the Rocketdyne J-2 liquid hydrogen engine is now slated for December of 1965.

INTERNATIONAL

Jordan Seeking U.S. Jets and Rockets

King Hussein of Jordan, who visited President Johnson on an official trip to Washington recently, is asking for more American military aid—with emphasis on supersonic jet fighters and rockets.

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Firms Vie for Apollo S-Band

Collins Radio Co. of Dallas and Philco Corp., Palo Alto, Calif., have been selected by NASA for competitive negotiations leading to a prime contract to develop the *Apollo* network S-band systems.

The estimated $5-million contract calls for purchase of two complete tracking and data acquisition systems with 30-ft.-dia. antennas and three electronic subsystems.

Other options available to the space agency—including 10 additional complete systems and 23 more subsystems—could push the total cost to $18 million.

Among the functions the single band will handle are tracking, telemetry, up-data and television and voice communication.

In the S-band system, the separate radio frequencies of these functions are combined into one coded carrier frequency and transmitted by a single antenna. The carrier is received by one antenna system and decoded into its individual signals.

The first two complete systems are to be installed at the Manned Space Flight Network stations in Bermuda and in Carnarvon, Australia. The first two electronics subsystems are to be integrated into the Jet Propulsion Laboratory's deep space antenna at Goldstone, Calif., and at the JPL launch monitoring and checkout station at Cape Kennedy, Fla. The third subsystem is to be a test and training unit to be installed at an *Apollo* network operational training site.

Recoverable Vehicles Predicted

Preferred approaches to the development of recoverable boosters for space launch vehicles are beginning to crystallize, Gen. B. A. Schriever told a National Space Club luncheon group. Although there is presently no proposal in DOD for such a system, within the next year or two such a proposal should be sent to DOD he said.

Noting that he has been "personally interested" in a recoverable booster program for a long time and that the Aeronautical Systems Division and "the West Coast" have been working on various approaches for the past two or three years, the Air Force Systems Command chief seemed to favor a vertically launched rocket system over a horizontal-take-off air-breathing system using hydrogen as a fuel. The latter, he said, in response to another question will not be achieved "until we solve the problems of supersonic combustion."

Even further down the road, Schriever pointed out, are the space plane concepts. This type of single-stage to orbit and return vehicle is "a long ways off" with much work still to be performed in the areas of propulsion cycles and heat exchangers.

Reminded that, following the reorientation of the Advent program, he had testified in favor of a separate military communications satellite system, Schriever was asked what his position was now. "I haven't changed my mind," he replied. This is in direct conflict with the efforts—directed by Secretary of Defense Robert S. McNamara—for the defense Department to attempt to negotiate an agreement for DOD use of the Comsat Corp.'s satellite system.

On the subject of the *Manned Orbiting Laboratory (MOL)*, Schriever said that the *Orbiting Space Station (OSS)* contracts due back to Space Systems Division next month had been re-oriented to contribute detailed technical information for the program definition phase of *MOL*. Also, he pointed out that *MOL* was a line item in the FY '66 budget which is in preliminary form now. On the subject of slippage in the *MOL* program, Schriever admitted that "we haven't got on with it as fast as we would like," but, lacking detailed schedules against which to measure progress, he would not term the delay in the program as slippage.

Improvements in re-entry vehicles, guidance accuracy and growth in propulsion systems will insure a continued high level of effort in the ballistic missile area. However, in terms of completely new systems, no such program is contemplated in the near future, Schriever said.

New Radar Under Development

ST. LOUIS—The Air Force has started development here of a field-evaluation model of a lightweight, low-cost, transportable surveillance radar system capable of 360-degree coverage.

The system, which weighs less than 200 lbs. and is designed for backpack transport by a seven-man

team, is aimed at providing early warning against very slow and low-flying targets. In its present configuration, it could act in conjunction with aircraft, missile or ground troop defensive units.

The radar development is being supported by the Air Force's Rome Air Development Center under terms of a 12-month, $207,000 contract awarded in March to Emerson Electric Co.'s Electronics & Space Div. in St. Louis.

Whereas the system requires a seven-man transport team, it can be set up and operated by only one man. Of the seven individual back packs, none is heavier than 30 lbs.

In the Emerson design, the 5.8-ft.-high, 8-ft.-wide parabolic mesh antenna sits on top of an erectable mast, which extends 60 ft. above ground at maximum height. The mast is constructed of 3-ft. sections of aluminum tubing (other materials are also being studied). Minimum height for the system is 11 ft.

Atlas Probe Under Way

The on-site explosion of an *Atlas F* ICBM at Altus AFB, Okla., May 14, the fourth such *Atlas* mishap in less than a year, has resulted in a renewed inquiry into the matter by the Senate Preparedness Subcommittee.

The subcommittee, headed by Sen. John Stennis (D-Miss.), said the three previous explosions, which occurred at Walker AFB, N.M., were extensively investigated, including an on-the-scene inquiry by a member of the staff. The subcommittee, since January, has also been investigating charges made by Sen. Barry Goldwater (R-Ariz.) in his campaign for the GOP Presidential nomination that U.S. missile defenses are "unreliable."

In the subcommittee's announcement, Stennis stated that "the number and frequency of the explosions raises very serious questions with respect to the *Atlas F* missile system."

SA-6 to Carry Boilerplate Apollo

The scheduled flight of the sixth *Saturn I* vehicle this week will mark the first launch of a boilerplate *Apollo* spacecraft into Earth orbit.

It will also be the first use of an active guidance system to place the S-IV second stage and payload into orbit.

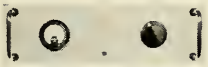
SA-6 launch is scheduled for no earlier than May 26. If successful, the second stage, an instrument unit

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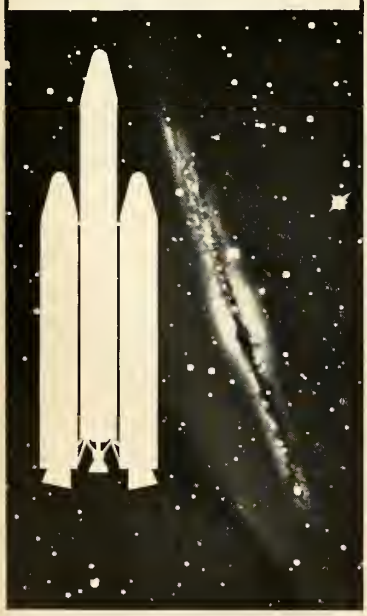
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Prime purpose of the flight is further qualification of the two-stage launch vehicle. Other primary missions are further tests of the propulsion system, structure and flight system and to prove the technique for separating the second stage from the booster.

Five *Saturn I's* have been launched successfully. In addition to *SA-6*, later vehicles in the series will also carry unmanned models of the *Apollo* spacecraft's Command and Service Modules. The last three *Saturn I* flights, *SA-8*, *SA-9* and *SA-10*, will carry meteoroid detection satellites.

AFES Gets New Commander

Maj. Gen. John W. O'Neill has been named to succeed Maj. Gen. Charles H. Terhune, Jr., as commander of the Air Force Systems Command's Electronics Systems Div. effective July 1.

O'Neill is presently serving as special assistant to Dr. Harold Brown, Director of Defense Research and Engineering, Dept. of Defense.

Electronics R&D Off $16M

Military communications R&D funds requested by the President in the Fiscal 1965 budget are approximately $165 million—a decrease of $16 million from the FY '64 figure of $181 million. This total excludes communications R&D funds associated directly with weapon system programs, but even in this area of funding, the total will be below that in FY '64.

This note of warning was sounded by Willie L. Moore, deputy assistant for communications, Office of the Director of Defense Research and Engineering, before a panel of the Armed Forces Communications and Electronics Association in Washington last week.

A breakdown of the requested funding—which may experience further Congressional reduction, Moore pointed out—included: exploratory development, $39.2 million; advanced development, $66.9 million; engineering development, $58.9 million.

DDR&E is looking to the Air Force's Rome Air Development Center for advances in hardened antenna systems in the HF, VHF and UHF ranges, Moore disclosed. While the Army, through its Electronics R&D Laboratories at Ft. Monmouth, will continue its efforts in the areas of vehicular and pack radio technology, the Navy will press its research effort in fundamental shipboard antenna design through the Naval Electronics Laboratory.

Martin Gets $38.2M for Sprint

The Martin Co.'s Orlando Div. has received a $38.2-million target-plus-incentive-fee contract from Bell Telephone Laboratories for further development and testing of the *Sprint* missile system, a part of the Army's overall *Nike-X* program (see p. 14).

Shots of the Week

The Air Force on May 19 launched an *Atlas-Agena* carrying an undisclosed payload toward polar orbit. Shot was from Point Arguello, Calif.

- NASA test pilot Air Force Capt. Joe Engle flew the *X-15* rocket plane to an altitude of 196,000 ft. from Edwards AFB, Calif., on May 19 in a study of optical distortion caused by high-speed flight. Top speed reached in the test was 3,477 mph.
- The Atomic Energy Commission on May 20 carried out what it called a "very successful" first full-power ground test of the Tory II-C reactor at the Nevada Test Site. There was no immediate announcement of the duration of the full-power run, but it appeared to be at least five minutes. The firing was intended to show the potential of the reactor for use in a ramjet propulsion system.

GE to Build ATS Stabilizer

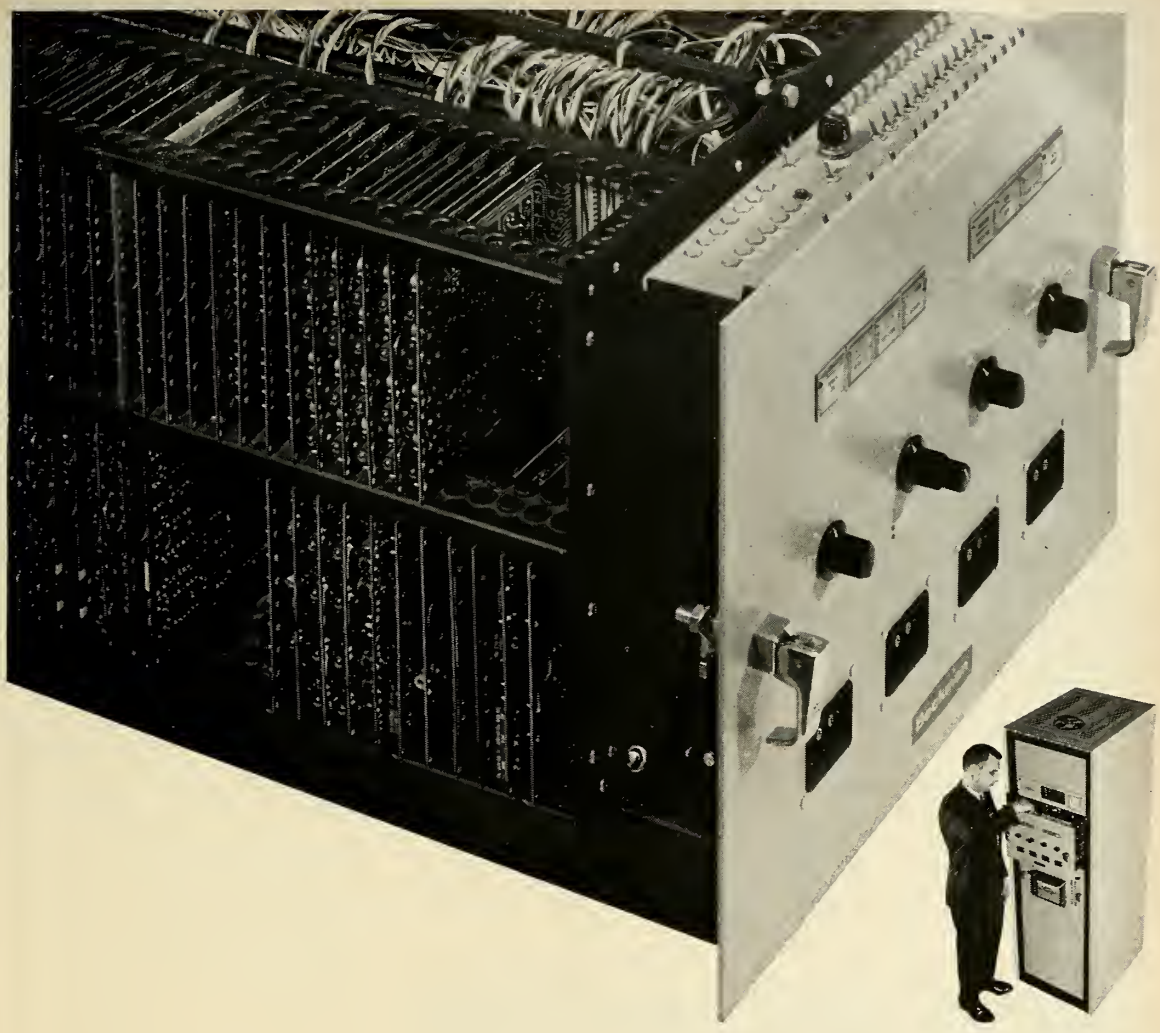
NASA is negotiating with General Electric Co.'s Valley Forge Space Technology Center on a contract to design and build gravity-gradient stabilization systems for the *Advanced Technological Satellite*.

Value of the contract is expected to exceed $5 million.

GE will supply gravity-gradient experiments to be carried on the 650-lb. satellites to be launched from Cape Kennedy by *Atlas-Agena* rockets beginning in 1966.

One satellite will be launched into a 6,500-mi.-high orbit and two into 22,300-mi.-high synchronous orbits. In addition, GE will supply two prototype and two engineering gravity-gradient system models plus ground operations and data analysis.

Gavity-gradient stabilization systems use the Earth's gravitational field to keep the satellite correctly aligned with respect to the Earth.



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Missile Site Radar Paces Nike-X

Part II of M/R report details progress in only U.S. A-ICBM program

by James Trainor

INTERCONNECTIONS between the *Nike-X* Multi-Function Array Radar (MAR)/Data Processing complex and the Missile Site Radar (MSR) are expected to provide the "techniques of engagement" essential to an effective anti-missile missile defense system.

Resembling a Marshall Islander's crude stick-and-tong navigation map, the hardened communications lines, which will tie the missile radars together with the MAR as well as with each other, provide the means of defeating the "fireball blackout" problem.

One of the most serious problems facing the designers of *Nike-X* was the possibility that an enemy would burst a precursor warhead over a defensive complex—blacking out its radars and providing a cover for the main attack. By interconnecting the MAR with the MSR's, however, the *Nike-X* system will have multiple look-angles—enabling it to see around the hot ionized particles and free electrons from the fireball. Fortunately, there is an optimum altitude for such a precursor burst—an area 10 mi. wide and centered at an altitude of 45 mi. Above this height, Defense officials point out, the fireball expands at velocities approaching 2,000 mph and quickly dissipates; below this altitude range, the atmosphere is thicker and, therefore, the fireball is smaller and the free electrons are more quickly absorbed.

Consequently, by siting the missile radars far enough away from the MAR, these radars can be used to feed information into the data-processing complex on the attacking re-entry vehicles if the main radar has been blacked out. The Missile Site Radars, of course, do not have the same capability as the MAR, but they can be used to provide data for discrimination to the data-processing unit. Tactical deployment configuration for the *Nike-X* calls for separating the missile sites from the MAR by approximately 15 mi.

Since each tactical *Nike-X* site will be tailored to the geometry or importance of the point complex it is defending, interconnection requirements will vary considerably from site to site. For example, defense of the New York area will involve more than one multi-function array and a large number of missile farms; the defense of an area such as Dallas would call for only one MAR and a proportionately smaller number of satellite missile sites. Interconnection plays a role—although a substantially lesser one—in providing support to individual point-defense systems. For example, the *Nike-X* complexes in the Baltimore-Washington-Philadelphia areas would be tied together and could support each other if called upon to do so. However, this is a bonus capability and plays nowhere near the role in the *Nike-X* program that the MAR-MSR interconnections do.

- **Traffic-handling capacity**—The switch from mechanically steered to electronically steered radars is probably the most important advance in the *Nike-X* system over the *Nike-Zeus*. These antennas, which can be hardened against attack, give the defensive system a quantum improvement in traffic-handling ability. *Zeus*, on the other hand, is limited in the number of targets that it can track. Also, the discrimination ability of the *Zeus* system is not adequate to the size of the threat it was expected to encounter in the 1970-80 time period.

Just as important as the MAR's ability to acquire and track large numbers of re-entry objects is its ability to provide greater refinement in size, shape and mass of objects in a re-entry covey. This gives the data-processing unit more information with which to select the warhead, or warheads, from the mass of decoys and debris which would accompany the re-entry body.

The use of a phased-array antenna at the missile site also enhances traffic-handling ability of *Nike-X*. Whereas the *Nike-Zeus* missile-tract radar could handle only one defensive missile in the air at a time, the Missile Site Radar can handle multiple *Sprint* and *Zeus* launchings—if the MAR/data-processing complex assigns a particular missile farm more than one target.

- **Nike-X progress**—At the moment, the Missile Site Radar is pacing the development of the *Nike-X* system. The final technical approach to the MSR is being finalized; once development is started, this unit, because of its shorter development time, is expected to catch up to the rest of the system.

MAR represents the main imponderable in the *Nike-X* development program, according to Defense officials. They say the main question to be answered is: "Can a phased array do all the things which are expected of it?" Although both the Army and the Dept. of Defense's Advanced Research Projects Agency (ARPA) have done work on phased arrays—most notably the Electronically Steered Array Radar (ESAR) built by Sylvania—neither has experience with a radar as sophisticated or high-powered as the MAR. "ESAR is a baby compared to a grown man," is the way one Defense official puts it. Tracking ability, traffic-handling capacity and discrimination are the major factors in MAR development.

Many preliminary answers to these questions are expected to come from the linear-array radar in the final stages of completion at White Sands Missile Range, N.M. Being built by Sylvania, the array is the first built-to-scale test device for the *Nike-X* program. Some test results are expected by this fall.

Initially, the radar will be used against targets carried by aircraft, but later in the program the Air Force's *Advanced Ballistic Re-entry Systems* (*ABRES*) program will provide targets. The *ABRES* vehicles are launched from Green River, Utah, by *Athena* vehicles into WSMR.

Another MAR to be installed on Kwajalein Island will more closely resemble the tactical version. A missile farm will be built on Meck Island north of Kwajalein. This will allow approximately the separation required between

the MSR and the MAR in the tactical deployment. These facilities will be used for a *Nike-X* intercept program similar to the *Zeus* intercept tests.

A major advance in the data-processing system for *Nike-X* is the large-scale application of microelectronic packaging concepts to the logic units. Data-processing units of the computer have been finalized, and the cells are being fabricated for mounting in planes and then in racks. The dramatic reduction in size achieved in the *Nike-X* computer was illustrated by one Defense official who compared one of the logic unit racks in *Zeus* with the same unit in *Nike-X*. The first, he said, was comparable to the standard, G.I. issue "in-box"; the second was the size of a book of matches.

Reduction in size is not important in itself. What is important is that, in spite of the fact that electrical signals travel at the speed of light, significant amounts of time are saved merely by reducing the transit times between elements. Although these time savings are measured in nanoseconds, the DOD official pointed out, they are extremely important in a ballistic missile defense system.

● **Nike-Zeus & Sprint**—The total number of intercept tests in the *Nike-Zeus* program is still tightly classified, but some DOD officials admit that they can't remember when they have had a failure in the program. "The last eight shots have been right in the bucket," one official says. Another claims that "it has been over a year" since there has been an unsuccessful intercept test. Closest to a failure in the test program to date was an instance during one salvo test when the second missile to be fired was aborted.

Recently, however, there have been failures in the *Nike-Zeus* program. These were caused by deliberate attempts to simulate *Sprint* performance with the *Zeus* missile. By commanding "hard-over" guidance signals to the missile, attempts have been made to simulate the aerodynamic heating problems which will be encountered in *Sprint*. The *Zeus* structure is not amenable to this type of exercise—as the resultant missile failures show.

At present, the *Zeus* intercept program is in its final stages, and some "targets of opportunity" are being engaged. The program is to end this year. Meanwhile, the Army is observing missiles launched from the Pacific Missile Range and recording the flights on tape. These tapes can later be run through the data-processing system and a missile fired against the tape—thus allowing intercept tests which are not dependent on an actual ballistic missile firing. (This approach, however, makes it difficult to define precisely "success" or "failure" in an intercept test.)

Sprint—the high-acceleration missile for low-altitude intercept of re-entry vehicles—is still in the initial design stages. Final composition and burning rate of the high-energy propellant are still to be determined. Design of the missile is to be completed by the beginning of calendar year 1965. A warhead for *Sprint* has already been designed, but is still to be tested as part of the U.S. underground test program.

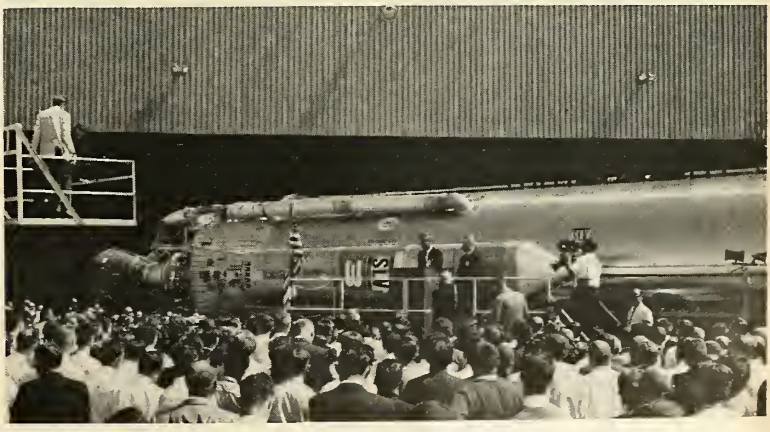
Sprint, like *Zeus*, is expected to use the jethead concept for final intercept. After the missile is fired and the first stage burns out, the jethead will coast until its orientation and relation to the re-entry vehicle are determined; then the motor will be fired so that the vector addition of the flight path and the jethead motor will result in an intercept of the re-entry body. *Sprint*, reports one official, has "considerable maneuverability" and, since the intercept is at a lower altitude, the dead zone (the area in which the warhead cannot be intercepted) is smaller.

Self-kill of one defensive weapon by another exploding nearby, and hardening of warheads by an enemy, are problems which are being designed around for both the tactical *Zeus* and the *Sprint* missiles. Warhead-hardening, in particular, calls for an estimate of the state of the art followed by design of the defensive weapon to counter warhead hardness—perhaps as much as four times beyond the technology.

Although the external configuration of the *Zeus* is the same, improvements in the missile have been considerable, DOD officials state. The first stage now uses a polybutadiene acrylic acid (PBAA) propellant in place of the original polysulfide solid-rocket motor. Improvements have also been made in the vanes and their hydraulic systems to overcome the high temperatures and stagnation pressures encountered during atmospheric flight by the missile. The re-packaging and refinement of components in the third stage of *Zeus* is also under way.

Zeus will be included in the *Nike-X* missile farm in order to give the system the flexibility to make long-range intercepts if the data-processing system and the MAR are able to discriminate the re-entry vehicle early enough. Another use for *Zeus* might be to fire it so that it intercepts the re-entry covey at the fringes of the atmosphere. By detonating it in this position, an impulse could be exerted on the lighter objects in the re-entry cloud separating them from the heavier decoys and the re-entry body. If the dispersion of the re-entry cloud were not too great and were the impulse strong enough, it might be possible to completely denude the warhead—and in the extreme case divert it from its target.

● **Special classification**—With the advent of the *Nike-X* program also came special security procedures. Reminiscent of the compartmentalization of the Manhattan project, these special security classifications severely limit access to information—even within the *Nike-X* project itself. ■



SSD Accepts Initial Atlas Standardized Launch Vehicle

THE FIRST Atlas Standardized Launch Vehicle (SLV-3) was accepted May 18 by Space Systems Div., Air Force Systems Command, in ceremonies at General Dynamics/Astronautics' San Diego, Calif., plant. SSD Commander Maj. Gen. Ben. I. Funk accepted the first vehicle, shown above. Speaking here is J. R. Dempsey, president of General Dynamics/Astronautics Div. Both the Air Force and NASA will use the SLV-3 for a variety of space launches.

Mueller discloses . . .

Apollo Logistics System Will Be Next Manned Space Flight Project

by Hal Taylor

THE NEXT STEP in the *Apollo* Logistics Support System (ALSS) following the award of two study contracts last week will be hardware development.

A space agency spokesman said the nine-month study contracts to the Boeing Co. and Bendix Corp. call for preliminary design of a payload that would be carried to the lunar surface by the Lunar Excursion Module truck. "From there," the official said, "we will move to hardware development."

At the same time, Dr. George F. Mueller, associate deputy administrator for manned space flight, told MISSILES AND ROCKETS "I would like to start development of the system in FY '66." He said that a real start on the program would take several hundred millions of dollars and added that he doubted such funds would be available in the next fiscal year.

Mueller said he does not believe there will be substantial funds for new manned space flight programs until Project *Apollo* funding starts to fall off in FY '67.

The study contracts with the two firms, however, were funded with FY '64 money.

In addition, $28 million has been requested for manned space flight study programs in FY '65 and it is certain some of that total will be available for ALSS. Together with a small amount of funding in the FY '66 budget, this could at least permit the space agency to select a prime contractor for the project.

● **Importance of comment**—While not optimistic about the chances of early funding, Mueller's statement was important because it marked the first official declaration by a NASA official that the ALSS system is the next new U.S. manned space flight project.

In announcing the selection of the two firms to perform the preliminary design phase, the space agency said that funding of about $1.5 million would be split about evenly between them.

Boeing will be supported in its study by General Motors Corp.'s Defense Research Laboratories and RCA's Astro-Electronics Div. The Bendix team is composed of Lockheed Missiles and Space Co. and the Hamilton-Standard Div. of United Aircraft Corp.

● **MOLAB priority**—The study contracts will be directed by the Marshall Space Flight Center. The firms will concentrate on the mobile laboratory (MOLAB), capable of supporting two *Apollo* astronauts for up to 14 days. Under some lunar surface conditions, such a vehicle would have a range of several hundred miles. A smaller effort will be directed to a study of a second payload, which includes both a stationary shelter and a smaller roving vehicle of limited range.

NASA announced the RFP on Mar. 16. A bidders' conference at Marshall on Mar. 27 was attended by 29 firms. Five companies submitted proposals Apr. 20.

The ALSS concept makes maximum use of *Apollo*-developed systems. In the ALSS concept, a *Saturn V* launch vehicle would launch into an Earth-Moon trajectory a manned *Apollo* Command Module, a Service Module and a Lunar Excursion Module (LEM) modified for unmanned delivery of equipment from lunar orbit to the lunar surface. The modified LEM has been called a LEM truck.

Payloads for lunar service operations would be stowed on the LEM truck. Following the ALSS landing, astronauts would arrive in the same area in an unmodified *Apollo* LEM to utilize the ALSS payloads in an exploration mission.

Either the lunar surface vehicle or the shelter-and-vehicle payload would weigh about 7,000 lbs., including scientific equipment. Total allowable volume for the payload would be about 2,000 cu. ft. ■

Welsh Says Disarmament Would Boost Space Funding

A TOP Johnson Administration official has declared that disarmament would greatly increase funding for the U.S. space program.

Dr. Edward C. Welsh, acting chairman of the White House's National Aeronautics and Space Council, said "it is my thesis that mutual disarmament would greatly increase the flow of funds and effort into space exploration and into the building of greater space capability."

In a May 21 address before the American Ordnance Assn., Welsh said "the ingredients of weapons system development are many, but the most valued are engineering, scientific and management skills as well as laboratories and production facilities in which those skills can be used.

"The country would probably gain the most or lose the least if the skills and facilities released from weapons system development went into space systems development," the White House official declared.

He recommended that space planners within the government—with the aid of industry—look forward with vision into the future and consider the many legitimate fields for extensive space research activities.

"If the planning is basically sound and is kept under constant review and if industry is kept closely tied in, we can utilize effectively every added resource that might be made available to the space program."

House knife wielded lightly . . .

FY '65 Missile/Space Money Bills Subject to Minimal Trimming So Far

by Heather M. David

MISSILE/SPACE INTERESTS have fared well in Congress so far this year.

Most of the big money bills have reached the halfway mark in the legislative process, now stalled temporarily during the Civil Rights debate. However, the lower funding limits traditionally set by the House are at a much more generous level than in previous years. Thus, the process from here on will be upwards, as the Senate restores some funds trimmed by the House.

● **NASA**—The House Appropriations Committee has voted a total of $5.2 billion for the National Aeronautics and Space Administration, $245 million less than the total combined Fiscal Year 1964 supplemental and FY 1965 budget requests.

The cut in effect drops almost all the supplemental request of $141 million, which in any case could not have passed through the Senate until after the fiscal year is concluded. Beyond that, the Appropriations Committee's action does not cut any deeper than did the House Science and Astronautics (Space) Committee, which earlier pared the FY 1965 bill to $5.19 billion.

Final floor action on the bill is expected early this week. Stiff opposition has been promised by Rep. Louis C. Wyman (R-N.H.), who contends that "the 1970 (manned lunar landing) target date is foolish." In remarks filed separately from the committee report, he further argued that "our target date in terms of American space policy should be simply that we will go to the Moon if, as and when our space technology and our pocketbook find it possible to do so, not by any set date."

Wyman pointed out that the *Apollo* program is contingent upon the success of the rendezvous capability which must be demonstrated by *Gemini*. He termed "inexcusable" the "long-lead-time advanced contracting for *Apollo* launch and space capsules and modules that we may never be able to use at all if *Gemini* doesn't work."

The New Hampshire Congressman further feels that man should not be on the Moon at all. He cited the $60,000 cost of the *Gemini* spacesuit as an indication of the costs which will be incurred in keeping a man alive on the Moon. "I do not believe this cost is worth the loss to Americans of other demonstrable societal benefits that we are denied because of the fantastic drain of federal funds in extra billions in a space program targeted at civilian scientific exploration of the Moon with the follow-on of Mars and Venus."

The action of the House Appropriations Committee in bringing the appropriations bill to the House floor before the authorization has been voted by the Senate Aeronautics and Space Sciences (Space) Committee, brought to a conference committee and then signed by the President, is subject to a point of order at any time during the debate. If a member raises the point of order, the NASA appropriations bill may be subject to a postponement of at least a month.

● **Breakdown**—The funds passed by the Appropriations Committee were broken down into $4.345 billion for research and development, $245 million for construction of facilities, and $610 million for administrative operations.

The committee specified that no more than $35,000 of the administrative operations appropriation should be used for scientific consultation or emergency or extraordinary expense.

The group again stipulated that "no part of the appropriation made available . . . (to NASA) . . . shall be used for expenses of participating in a manned lunar landing to be carried out jointly by the United States and any other country without consent of the Congress."

The Senate Space Committee still has not reported on the specific cuts that it applied to the authorization bill, except to say that it restored $52 million of the $110-million House cut (M/R, May 11, p. 9).

The report, imminent for some weeks, is expected to show that the Senate committee has restored 50% of cuts made in construction of facilities, and only partial funding in the space sciences programs.

It is understood that the Senate has upheld the $4-million addition made for advanced solid and liquid propellant research, but has removed the stipulation that it must be broken into $1-million and $3-million funds respectively.

● **Weather Bureau**—The House has already passed the Department of Commerce appropriation, including a request for funds for an interim operational satellite system based on *Tiros* technology.

While the original Bureau of the Budget request was for several millions more, this was reduced to $11.5 million at the request of the Administration in the midst of the committee's consideration. The committee further cut this to $10 million.

● **Atomic Energy Commission**—The Joint (Congressional) Atomic Energy Committee's action in adding $14 million to SNAP research (M/R, April 27, p. 18) to insure flight-tests of SNAP 10A was fully endorsed by the whole House. The House also upheld full funding for *Rover* at $84 million, and a $1.6-million cut in Pluto. Since the JAEC is a joint Senate-House committee, the bill awaits only Senate floor action.

● **NASC**—The National Aeronautics and Space Council's budget was cut by the House Appropriations Committee by $25,000. This, the committee said, will maintain a staff with two members less than it had last year.

The Dept. of Defense appropriation bill should move quickly through the Senate once the Civil Rights debate is resolved. Hearings before the Senate Appropriations Committee were held concurrently with the Senate Armed Services Committee during the authorization process. This means that the committee should be ready for a vote at the call of Defense Appropriations subcommittee chairman Richard B. Russell (D-Ga.). ■

RCA Unveils Magnet Breakthrough

PRINCETON, N.J.—The world's most powerful superconductive magnet—generating fields of 107,000 gauss—is now out of the development stage at RCA's David Sarnoff Research Center.

The experimental RCA magnet weighs 26 lbs. and resembles a half-gallon paint can in shape. It operates in a bath of liquid helium after being started by the output of 6-v storage batteries. The working field diameter is one inch.

A nonsuperconductive system capable of generating such high fields would weigh tons, use almost 1.5 million watts of power and demand the cooling ability of a small river.

Magnets based on the RCA 107 will allow scores of budget-limited labs to probe deep into the mysteries of solid-state physics, atomics and related areas. The current model will be marketed later this year.

The magnet has significant applications in electrical power generation programs such as MHD generators and controlled nuclear fusion. Such devices can also function as energy storage units—capable of releasing enormous bursts of power over a short period. There are both space and military needs here.

Space propulsion techniques and reentry protective envelopes need the super-cold magnets. There is even the remote possibility of shrouding an entire space vehicle in such a high field —which would block all charged particles.

● **Super-cool electronics**—A revolutionary superconductive microwave parametric amplifier was also disclosed at the RCA press briefing by Dr. Leon Nergaard. While largely experimental, the device consists of a film of superconductor on a block of rutile mounted atop a quartz heat sink in a waveguide tube.

The unit can amplify radio signals oscillating at a frequency of six billion cps when immersed in liquid helium. Amplifiers based on this development may operate at far higher frequencies than currently possible—opening wide ranges of radar, radio astronomy and communications channels.

RCA has been conducting evaluation studies for NASA's Lewis Research Center into the feasibility of designing high-field, large-bore superconductive magnets. One current contract with the space agency calls for investigations into a 150-kilogauss superconductive magnet with a 1-ft.-dia. bore.



RCA'S SUPERCONDUCTING magnet is lowered into liquid helium bath.

RCA spokesmen are confident that even larger diameters can be built with the technology in design and materials developed in the 107 kilogauss model.

● **Haynes-Stellite base**—The RCA 107 breakthrough is based primarily on several processes leading to a tough but flexible niobium-tin ribbon. Pure, single-phase, crystalline niobium stannide (Nb_3Sn) is continuously deposited on 0.090 x 0.002-in. Hastelloy ribbon through a vapor-deposition technique.

The coated high-strength alloy ribbon is then covered with either silver or copper in an RCA-developed electroplating process. This coating improves flexibility and enhances the electrical properties of the ribbon.

The Nb_3Sn deposition is superconductive as deposited and needs no heat-treating cycle to reach the zero-resistance properties. The niobium-tin layer is extremely uniform with little or no voids and imperfections. Current densities in the 200,000 to 300,000 amp/cm² range at 100,000 gauss result.

The RCA 107 magnet uses 4,450 meters of Nb_3Sn ribbon wound on two stainless steel coil forms—the smaller 2.8-in. OD being inserted in the 3.4-in. bore of the larger.

● **Three-coil design**—The windings on the outer coil are electrically connected as two separate coils so that, together with the inner coil, the complete magnet is electrically operated as three coils.

Maximum critical current in the inner windings is obtained by developing an ambient magnetic field with the windings of the outer coils. The 30-kilogauss field developed by the outermost coil (5.6-in. OD, 3.5-in. ID, 5.4 in. long) fully stabilizes all internal windings.

The adjacent central windings (4.3-in. OD, 3.5-in. ID, 5.4 in. long) are then brought to the critical current of 117 amps and a field of 56 kilogauss is developed in a usable 3.4-in. bore.

The smaller stainless steel coil form (windings 2.8-in. OD, 1.25-in. ID, 3.5 in. long) is also in a fully stable ambient magnetic environment, and reaches the expected critical current for the internal windings of 60 amps in the highest field. The measured field at this current, using Hall probes calibrated at NASA's Lewis Research Center, reaches a maximum of 107 kilogauss. The full field has been attained repeatedly.

In addition, tests of individual coil sections and combinations of sections yielding intermediate fields were repeated many times with all critical currents remaining reproducible. RCA experts claim these results demonstrate the complete absence of the troublesome "training effect" found in several other superconductive materials.

● **Zero is a low number**—The stored energy developed in the magnet at 107 kilogauss is 20,500 joules. When the magnet is driven "normal"—the point at which it loses its superconductivity—this stored energy is dissipated in seconds through currents induced in 11 sheets of copper interwound periodically between ribbon layers.

The dissipated energy heats the helium in the dewar, and while RCA researchers drove the magnets normal repeatedly, no coil damage resulted.

The maximum field that will continue to support such large currents for the RCA vapor-deposited ribbon is not yet known. The RCA ribbon retains its superconductivity even when flexed. Tested at 4.2°K, superconductive performance was not affected at stresses exceeding 115,000 psi. ■

First of five tests . . .

Apollo Command Module Safely Recovered in Escape System Evaluation

by Rex Pay

WHITE SANDS MISSILE RANGE, N.M. —The *Apollo* launch escape system successfully lifted a boilerplate Command Module away from an exploding *Little Joe II* booster traveling at Mach .94 at an altitude of 21,000 ft. mean sea level.

A signal from the ground exploded the booster 30 sec. after lift-off on May 13 and triggered the launch escape system. Separation and recovery of the Command Module then went as scheduled—except that one of the three 88-ft. main chutes that lower the CM to the ground broke free after deployment.

Since the three chutes form a redundant system, landing under two should not damage the spacecraft. The ground-impact velocity was raised from 25 ft. per sec. to 30 ft. per sec., comparable to that in *Mercury* capsule recovery.

The capsule landed in an upright position and first visual reports indicated no damage.

● **First of five**—This was the first of five High-Q tests that will check whether the launch escape system can separate the manned capsule from its booster at high dynamic pressures in the 600-900 mph speed range.

Astronauts will rely on this system to put a safe distance between them and their booster if a malfunction occurs during launch.

In this first test, at a Q of 660 lb./sq. ft., the system was designed to put the module 100 ft. away from the booster in one second.

Initial data indicated that all test objectives had been met. These also included proving out the tower structure connecting the escape rockets to the Command Module, and demonstration of correct operation of the Command Module separation systems. Telemetry detailed the aerodynamic stability characteristics of the escape configuration and the aerodynamic loads on the entire launch system during the boost phase.

Later tests in the series will study separation at maximum Q (785 lb./sq. ft.) and at altitudes up to 100,000 ft.



BOILERPLATE Apollo Command Module apparently undamaged after landing in desert.

The boilerplate Command Module used in the test was mounted on an *Apollo* Service Module. Made chiefly of aluminum and steel, both modules duplicated the external size, shape, structural soundness and center of gravity of later spacecraft. *Apollo* Command and Service modules are being made by North American Aviation's Space and Information Systems Division, under the program management of NASA's Manned Spacecraft Center, Houston, also responsible for project management of the *Little Joe II-Apollo* shots. Support for these shots is provided by the U.S. Army, White Sands Missile Range.

● **Sequence**—The 303,000-lb.-thrust *Little Joe II* booster developed by General Dynamics/Convair lifted the Command and Service modules 17,000 ft. above the range at a 56° angle of attack. At this altitude, a ground command exploded the booster, fired explosive bolts to release the Command Module, and ignited the Lockheed launch-escape motors.

Explosion of the booster took place 5½ sec. before thrust would have started to decrease, about 13 sec. before tail-off.

Burning time of the 155,000-lb. escape motors was designed to be 8½ sec. Exactly 15.4 seconds after booster thrust termination, the Thiokol escape-tower jettison motor fired, separating the tower from the module.

At launch plus 50.1 sec., the Northrop Ventura Earth-landing system started the parachute deployment sequence: first a small drogue parachute, them three 10-ft.-dia. Ringslot pilot chutes (at launch plus 152.9 sec.) and finally deployment of three 88-ft.-dia. Ringsail parachutes.

Preliminary inspection of the capsule at the recovery area suggested that the nylon lines of one of the main chutes fouled a component on the capsule and were cut. W. Etherton, NASA Subsystem Manager, *Apollo* Earth Landing System, said the component was placed on board for the purposes of the test and would not be on the operational spacecraft. ■

HONEYWELL INSTRUMENTATION

Two New Instruments Expand Line of Strip Chart Recorders

PHILADELPHIA — Introduction of the *ElectroniK 16* wide-chart recording potentiometer and the *ElectroniK 19* portable laboratory recorder greatly increases the performance capability of Honeywell strip chart recorders for test facility and laboratory use.

The *ElectroniK 16* recorder is extremely convenient to install, maintain and use. It mounts directly into a 19-inch relay rack without adapters or filler panels and has a new, high-performance, transistor servo-measuring unit. Chart-changing has been greatly simplified and an optional chart transport, which can be preloaded, permits charts to be changed in approximately 10 seconds. The *ElectroniK 16* is available in single, two-pen or multipoint models.

Mechanical layout of the recorder is such that most available options and accessories have their own unique locations on the chassis. Many options can be added later in the field—no need to return the instrument to the factory.

The *ElectroniK 19* portable lab recorder, a highly versatile instrument, is capable of measuring voltages from 100 microvolts full scale to 100 volts dc full scale without auxiliary equipment. Among other features, it has a tilting chart platen and thumb-wheel selection of 10 chart speeds.

The well-known *ElectroniK 17* recorder is ideal where mounting space must be conserved and accurate, low frequency dynamic measurements are required. The instrument features the infinite resolution *Stranducer* rebalancing element and solid-state circuitry. One or two independent full-width recording channels can be provided on a six-inch strip chart. Two chassis, each with one or two recording channels, allow recording of up to four independent channels in only 14 inches of vertical space in a standard 19-inch relay rack.

The *ElectroniK 18*, a single-pen, small-case recorder, is suitable for many demanding assignments, where equipment cost must be minimized.

ABRIDGED SPECIFICATIONS FOR STRIP CHART RECORDERS

				
	ElectroniK 16 (Single and Two-Pen Recorder)	ElectroniK 17	ElectroniK 18	ElectroniK 19
Calibrated Accuracy	±¼ of 1% of span for mv ranges	±¼ of 1% of span	±3/10 of 1% of span	±¼ of 1% of span or 1 microvolt, whichever is greater
Dead Band	0.1% of span	0.15% of span	0.2% of span	0.15% of span
Chart Speeds	From ½ inch/hr. to 4 inches/second	½ to 1800 inches/hr.	½ to 120 inches/hr.	10 indicated speeds from 10 minutes/inch to 1 second/inch plus "stand-by"
Chart	11-in. calibrated width, 122 ft. long	6-in. calibrated width. 126 ft. long	6-in. calibrated width, 126 ft. long	6-in. calibrated width, 126 ft. long
Span Step Response Time	1 second full scale	1 second full scale	1 second full scale	Less than 0.5 second full scale
Calibration	D-C voltages and currents, thermocouple, radiation pyrometer, resistance thermometer, tachometer	D-C voltages and currents, thermocouple, radiation pyrometer, resistance thermometer, tachometer	Thermocouple, radiation pyrometer, millivolts, milliamperes	D-C voltages
Ranges	Minimum 1 millivolt full scale Maximum 300 volts full scale	Minimum 1 millivolt full scale Maximum 300 volts full scale	Minimum 1 millivolt full scale Maximum 100 millivolts full scale	0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20, 50, 100 millivolts full scale and 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20, 50, 100 volts full scale
Approximate Weight	85 lb.	Single chassis 46 lb. Dual chassis 116 lb.	46 lb.	Less than 20 lb.
Price Range (no options included)	$1000—1975	$755—2680	$615	$1100 net
Circle reader service card #	25	26	27	28

(All prices and specifications subject to change without notice.)

HONEYWELL, Philadelphia Div., Philadelphia, Pa. 19144 • Denver Div., Denver, Col. 80217

NEWS

MILITARY EDITION

Number 3-MI

Four *Visicorder* Oscillographs Offer Flexibility in Dynamic Data Recording

DENVER—Honeywell's line of direct-recording *Visicorder* oscillographs now includes models to fit almost every conceivable data recording need in the aerospace and scientific areas.

The 36-channel Model 1612 instrument, for instance, is available in a configuration that meets rigid military specifications for radio frequency (RFI) suppression. Another optional feature of the Model 1612 permits use of the new, fast-processing develop-out papers, such as Kodak *Ektaline* Series and *Du Pont* 2, 3, or 4; 200 Series.

The Model 1508, like the Model 1612, is designed for rack-mounting in data systems. It records up to 24 channels of data simultaneously, yet occupies only seven inches of rack height.

The Model 1108, the most complete 24-channel oscillograph on the market, and the small, inexpensive Model 906, a 14-channel instrument, are designed primarily for bench use.

All four instruments are based on the Honeywell-developed principle of using ultraviolet light to record data on light-sensitive paper, thus providing instantly readable, permanent oscillographic records without chemical processing.

The accompanying chart shows the outstanding features of each instrument.

8 Graphic Recorders Fill Test Data Needs

PHILADELPHIA—Eight graphic recorders now available from Honeywell's Philadelphia and Denver Divisions will satisfy most requirements for the recording of missile data falling in the DC-5000 cps range. The group includes four *Visicorder* oscillographs and four strip chart potentiometric recorders.

The wide choice of instruments available, along with the variety of options offered, enables users to select recording systems or individual units that will efficiently meet requirements. The instruments can be specified for rack or panel mounting, with laboratory feet, or for mounting in mobile consoles.

ABRIDGED SPECIFICATIONS FOR *VISICORDER* OSCILLOGRAPHS

HONEYWELL







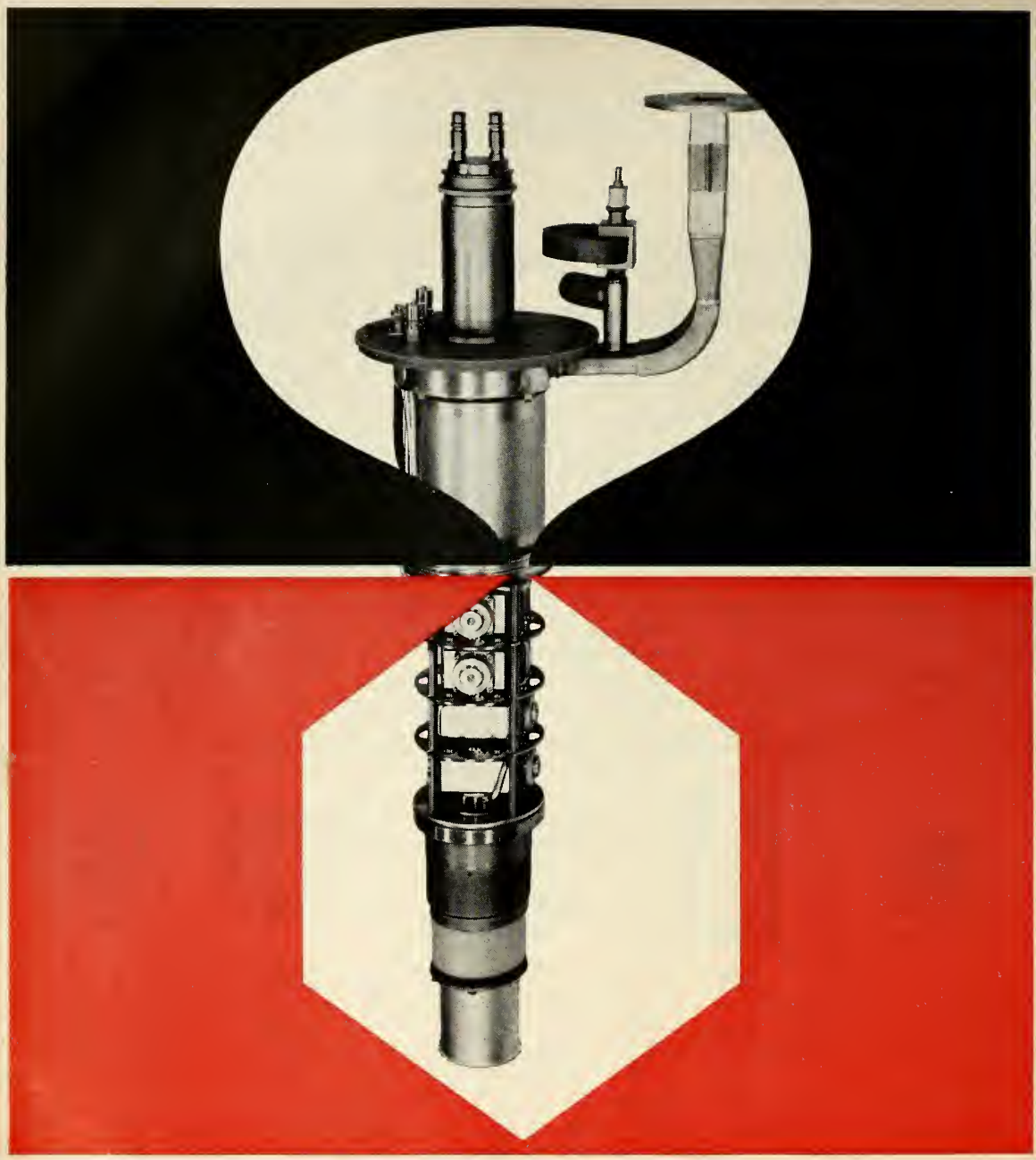


	1612	1108	1508	906
No. of Channels	36	24	24	14
Paper Width	12″	8″	8″	6″
Paper Speeds	15—.1 to 160 ips	15—.05 to 80 ips	12—.1 to 80 ips	4—.4 to 50 ips
Frequency Response	DC-6000 cps	DC-6000 cps	DC-6000 cps	DC-6000 cps
Writing Speed	50,000 ips +	50,000 ips +	50,000 ips +	50,000 ips +
Record Reverse	Yes	Yes	No	No
Heated Platen	Optional	No	Optional	No
Latensifier	Optional	Optional	Optional	Optional
Paper Takeup	Built-in	Built-in	Optional	Optional
RFI Qualified	Yes—Optional	No	No	No
Develop-Out Capability	Yes	Yes	Yes	No
Gridlines	Built-in	Built-in	Built-in	Optional
Time Lines	Optional	Built-in	Optional	Optional
Trace Identification	Built-in	Built-in	Built-in—Optional	Optional
Trace Numbering	Optional	No	Optional	No
Galvo Intensity Control	Auto & Manual—Built-in	Manual—Built-in	Manual—Built-in	Optional
Remote Operation	Yes	Yes	Yes	Yes
Auto. Record Length Control	Built-in	Built-in	No	No
Paper Supply Indicator	Built-in	Built-in	Built-in	No
Price Range	$7850-14,375	$4925-5275	$2775-5875	$1855-2700
Circle reader service card #	29	30	31	32

(All prices and specifications subject to change without notice.)

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Technical Countdown

ELECTRO-OPTICS

Portable "Sun" To Test Solar Cells

A portable solar-panel exciter developed by Electro-Optical Systems, Inc., Pasadena, Calif., enables indoor testing of spacecraft solar panels for the first time. The device eliminates previous dependency on the Sun itself for cell checkout, minimizes related contamination risks and permits quick testing of the panels at any time prior to launch, EOS claims. The unit illuminates an area 3 ft. square at a distance of 6 ft. using an array of floodlamps individually controlled for color, temperature and intensity. Level of intensity can be adjusted up to 140 mw/cm². Uniformity of intensity is ±5% and tungsten-light color temperature is adjustable to 2,800°K.

MATERIALS

CORE Delivered for Langley Accelerator

Langley Research Center's $12.4-million synchrocyclotron and radiation laboratory are scheduled for completion by late fall, 1965. The 6-million-lb. magnet core for the accelerator, biggest ever built by Bethlehem Steel Co., was delivered recently to the Newport News, Va., laboratory site. Comprised of forged, annealed, steel plates weighing from 10,000 to 609,000 lbs. each, the rectangular core was built under a $1.3-million contract. Contractor for the accelerator is Catalytic Construction Co. Capable of producing protons with energies up to 600-million electron volts, the vehicle will be used for advanced radiation-effects studies in support of future space missions, Bethlehem said.

ELECTRONICS

U.K. To Use Polaris Checkout System

The *Polaris* Mark 7 automatic test and checkout system will be employed by the British in their ballistic-missile nuclear submarines. Seven MTRE's (Missile Test and Readiness Equipment) will be supplied by Northrop's Nortronics Div. to Lockheed Missiles and Space Co., *Polaris* FBM prime contractor. As presently planned, five systems are slated for installation aboard U.K. submarines, one will be used at the Royal Navy *Polaris* School at Faslane, Scotland, and the last will be held as a spare.

Retired Transmitter Called to Active Duty

An old AN/FRT-10 transmitter, in storage for 12 years, will be modified and installed by Westinghouse in the Navy's Guardamar, Spain, radio station. The 500-kw transmitter will be converted from a Class C amplifier to linear operation. The resulting low-frequency system, operated as a single sideband transmitter, will be the most powerful of its type in existence, Westinghouse disclosed. The station will be ready for operation early in 1965 for fleet communications.

Clock Divides Seconds Into 10^5 Increments

A time standard unit providing accurate time intervals to 10 microseconds is under development by IBM for NASA's Manned Spacecraft Center computer complex. Required for precise time coordination at the big facility, the electric clock is a part of the real-time computer system being developed by the Federal Systems Division for MSC under a $30-million contract. The clock will provide a continuous time reference for the programs used in four IBM 7094 computers.

Minuteman C&C Radio Tests To Begin

Warrensburg, Mo., one of the worst radio reception areas in the U.S. will be employed by Sylvania Electric Products, Inc., for testing the *Minuteman* command and control radio subsystems. The radio system is a backup for the normally employed hardened cable system installed in the *Minuteman* launch sites. To support the tests and help provide more meaningful data, the National Bureau of Standards Field Station at Warrensburg will record the noise intensity due to atmospherics during the Sylvania tests. Testing will be completed this year.

PROPULSION

UTC To Produce Titan III-C Retrorockets

Over 200 solid-propellant retrorockets for *Titan III-C* staging will be supplied to Martin-Denver by United Technology Center under a recently announced $1.5-million contract. The 85-lb. rockets, developed by UTC for *Titan II*, will provide separation of the booster and core stages. Each booster will carry eight of the 4,500-lb.-thrust staging rockets plus an aft cluster of four and a forward cluster of four. The 5-ft.-long x 6-in.-dia. retrorockets differ only in nozzle configuration from the earlier *Titan II* version, UTC said.

SERT Test Objectives Will Still Be Met

A 30% reduction in testing time for the two ion-propulsion engines aboard the *SERT-1* (*Space Electric Rocket Test*) spacecraft will result from miscellaneous payload additions totalling close to 100 lbs. Each thrustor will run for 20 minutes instead of 30 minutes as originally planned. *SERT* will flight test a contact ionization type thrustor developed by Hughes Aircraft Co.'s Research Laboratories and an electron bombardment system built by NASA's Lewis Research Center. The spacecraft will be launched aboard a *Scout* rocket from Wallops Station within two months. Test objectives during the 40-min. ballistic flight—to prove feasibility of operating ion engines in a true space environment and to demonstrate beam neutralization in space—will still be met, project officials assert.

ASTRONAUTICS

Soviet Satellite Sprouts Wings

Aerodynamic control of an orbiting satellite is proposed in two recent Soviet publications including Pravda as a means for "rapid, extremely evasive reconnaissance maneuvers from both high and low vantage points." In translations of the articles prepared by Electro-Optical Systems, Inc., Pasadena, Calif., the Soviet Union "is developing a winged reconnaissance satellite (combination aerodynamic/propulsion system), which will be capable of rapidly changing orbital plane as well as flight trajectory during an orbital perigee which passes through the Earth's atmosphere." The translation explains that wings are used on the vehicle to simplify the shift maneuver while eliminating heavy propellant consumption.

260-in. Booster Insulation Based On Minuteman, Polaris Technique

Goodyear will manufacture insulation for Aerojet-built big solids; will use monolithic installation to avoid quality assurance problems

by John F. Judge

AKRON, OHIO—Insulation techniques developed by Goodyear Tire and Rubber Co. for the *Minuteman* and *Polaris* motor case programs are evolving into an on-site application method for Aerojet-General's 260-in. solid booster project.

The Missile Products Dept. of Goodyear's Aviation Products Div. will insulate the half-length, 260-in.-dia. case at Aerojet's Dade County, Fla., production and test-firing site under a contract exceeding $1 million.

The Goodyear task consists of manufacturing large segments of insulation that is then shipped to the Aerojet plant and installed by Goodyear experts under controlled conditions.

The Goodyear approach to rocket insulation is through matched die molding techniques. The firm has two large Verson presses capable of holding the workpieces at designated temperature levels for a controlled cure cycle.

Experience with this technique has been acquired in fabricating insulation for the *Minuteman* third stage and both stages of the *Polaris* family. The 260-in. case program will involve autoclave vulcanization of the rubber segments.

● **Continuous quality checks**—An intensive quality assurance program follows the rubber from its delivered condition through fabrication to case installation. The monolithic installation method avoids quality assurance problems associated with hand lay-up of innumerable plies with the several bonding steps in the case itself.





LEFT: Insulation segments in forward end of 120-in. case are sealed around their periphery and a vacuum is pulled in the Goodyear-developed installation technique. RIGHT: Insulation application method was first developed using this subscale motor case. Except for fixturing, exactly the same approach will be taken with 260-in. motor case at Dade. MIDDLE RIGHT: Center insulation strips are fitted and bonded to 120-in. case wall. Materials handling wall is visible above lights. Massive pieces of insulation are moved into position by a dolly system riding on this track. FAR RIGHT: Insulation is cured at Goodyear Akron plant in this 15 x 45 ft. autoclave. A typical 260-in. insulation segment may take up to 40 hours at 300°F and 100 psi. Nozzle liner will take considerably longer.

By supplying finished insulation to the large case, Goodyear builds a high confidence level into the product before it reaches its operational area. The huge size of the booster necessitated a segmented approach, but Goodyear will insulate the smaller qualification motors in exactly the same manner to establish application parameters and prove out the technique in actual sub-scale firings.

The case itself will form part of the preparation building at Dade by fitting the aft end into an airlock structure provided by Aerojet. The entire case will be covered with a temporary structure to aid in temperature control.

The inside of the chamber will be maintained at 70°F and about 30% relative humidity. The temporary structure, 60 ft. high and 150 ft. long, will aid in this process control. The moisture within the case itself will be rigidly controlled.

A double track will be mounted at both ends of the case, running down the center axis. The entire chamber will be mounted on rollers. Insulation segments will be carried to the point of application by a cart riding on this track. Hydraulic jacks will hold the applied insulation in place until the vacuum can be applied and the adhesive cured.

Goodyear specialists will always be working downward in applying the insulation to the cylindrical longitudinal sections, the forward dome and the aft curvature. The case will be rotated as needed to bring work areas into place.

● **Applying the insulation**—The insulation will be applied on the longitudinal walls in alternate strips until the case wall is completely covered. A second layer is then applied with the longitudinal seams overlapping. The strips will be butt-jointed all around. An epoxy binder is laid down before the insulation strips are applied. A fishnet air bleeder is added, and then the insulation.

The forward dome insulation is applied in eight separate gore sections. Each is laid on the epoxy-fishnet combination and then an airtight condition is created by taping down the gore edges. Air is pumped out and the fishnet bleeding mechanism assures Goodyear engineers that all entrapped air has been removed. The vacuum is held until the bond cures.

The gores are laid up in sections. Edges are tapered so that each joint is V-shaped, with the metal case visible between joints. After all eight sections have been vacuum-bag bonded at ambient temperatures, the joint areas are filled with a special compound.

This filler is General Tire's V-61—applied by trowel and allowed to cure in air, without any temperature-vulcanization process, to the same physical properites as the prefabricated gores of insulation. V-61 is used in the forward dome, the center sections and with the shrinkage boot.

The aft curvature—that section of the aft closure which is integral to the case—is insulated in much the same manner. When the case is fully insulated and the material surfaces buffed, the previously installed casting collar will be used to face off the insulation.

A grinding machine will then be fitted into tracks on the collar, and Goodyear technicians will grind the mating edges of the aft section insulation in a step pattern designed to fit the nozzle closure insulation.

Aft closure insulation is fabricated at the Akron facility in a single section. The entire mass is mounted on an eight-segment mandrel, together with a plaster ring to hold dimensions. The part is vulcanized, inspected and shipped on this mandrel.

The insulation is mated to the nozzle section by the nozzle fabricators—Thompson Ramo Wooldridge's Electromechanical Division. The 25-ton mandrel-insulation complex is tipped over and the mandrel removed. The nozzle is lowered over the insulation. The entire assembly is then barged to Aerojet's Dade County plant in Florida from the TRW Cleveland plant.

● **Processing the rubber**—A rubber boot is installed in the forward dome. A metal spark-test strip is installed in the boot seam to test the joint and is removed after the boot joint has passed inspection.

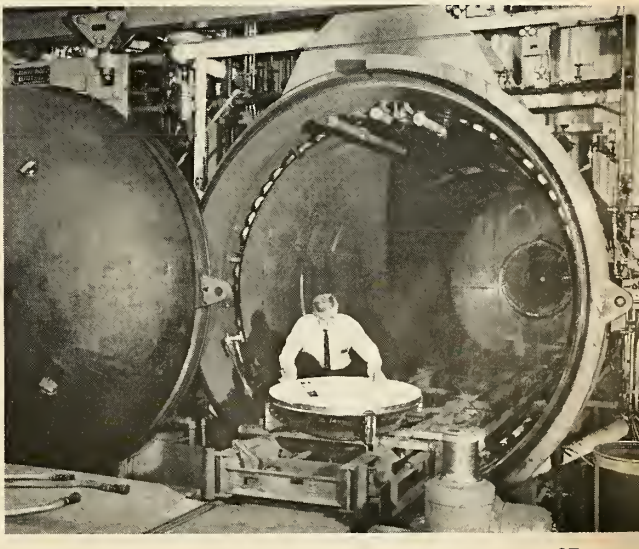
The rubber insulation is a Buna-N acrylic synthetic loaded with asbestos. It is received in the green or uncured condition in calendered sheets from General Tire & Rubber Co. General Tire also supplied Goodyear with material for the *Polaris* first-stage motor case insulation.

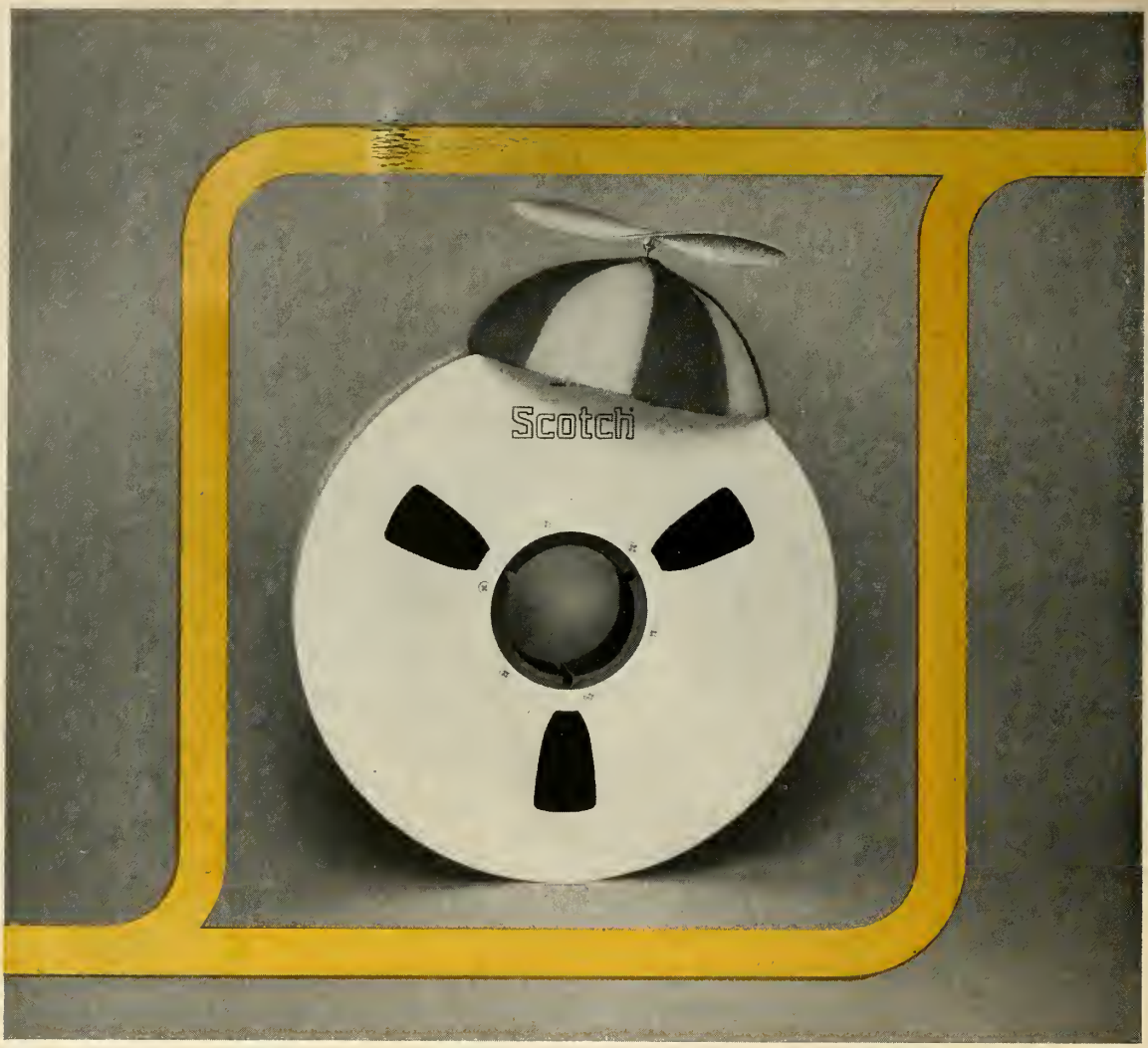
All incoming rubber on the 260-in. program is minutely inspected as it is received. Sheets are then cut to the specific patterns and shapes required for case installation. These are prepared in layers.

The patterned layers are laid up in a forming tool, blanketed and vulcanized in an autoclave. One-piece sections result, ready for shipment to the Aerojet facility—after an intensive inspection.

Voids and other imperfections up to a certain size can be repaired in the cured condition. The procedure involves cutting out the affected area and then troweling in the putty-like hot stock. This material is essentially the same as the virgin insulation and is used both as a repairing material and as the aft dome sealant. ■







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Meteoroid Protection Developments Aired at AIAA Meeting

by Willard E. Wilks

PALM SPRINGS, CALIF.—Promising developments in meteoroid-protection research were reported here recently at the American Institute of Aeronautics and Astronautics Fifth Annual Structures and Materials Conference.

Study of impact effects on meteoroid shielding configurations for velocities up to 60,000 fps suggests that current protective requirements against the hazard might be reduced, F. C. Posever, F. L. Rish and C. N. Scully of North American Aviation's Space and Information Systems division told the conference.

S&ID obtained cratering and penetration data with spherical borosilicate glass projectiles 50 microns in diameter at velocities from 20,000 to 60,000 fps against aluminum, magnesium, and steel alloys, and beryllium multiple-sheet target materials. Results included consideration of an appropriate meteoroid mass-flux distribution and impact probability, including effects of higher probability of oblique impact, which is associated with smaller penetrations.

● **'Bumpers' questionable**—General Motors Corp.'s GM Defense Research Laboratories, Santa Barbara, Calif., reported on hypervelocity impact studies showing that the meteoroid bumper concept, using a thin protective shell in front of the primary structure, may do more harm than good at lower impact velocities. This apparently results from less heating of projectile debris at lower speed impact, which results in greater spall damage by the surviving debris.

At the same time, the laboratory's experiments with aluminum tubular structures, which have been considered for use as space radiators for nuclear auxiliary power systems, showed a stainless steel liner inside the tube was beneficial, preventing the penetration and spalling that occurred in unlined tubes.

The GM laboratory's work with different projectile shapes has military implications for both offense and defense, showing projectile shape can strongly influence damage inflicted on structures. Provided projectile orientation at impact also could be controlled, there could be A-ICBM and anti-satellite applications, researchers reported.

Projectile shapes studied included spheres, flat plates, rings, rods and hollow cylinders. Rod projectiles produced greater penetrations than other configurations of equal mass, and X-ray photographs showed a significant portion of the rod was still intact following penetration.

The GM facility has devoted some study to the flash associated with impact, and proposes that the spectral characteristics of this emission could be a potential source of information for determining a hit on a space target as well as identification of target material and information on damage inflicted.

● **Honeycomb detrimental**—Use of honeycomb material for meteoroid protection would increase damage from impacts, according to results of hypervelocity impact work at NASA's Ames Research Center.

Because of the desirability of honeycomb as a structural element, researchers James L. Summers and C. Robert Nysmith studied honeycomb in some detail. Results were that honeycomb walls act to channel spray particles resulting from impact into a confined, highly damaging cluster of pulverized material that blasts through the rear sheet of the target material.

In an effort to determine whether the harmful effect of honeycomb could be minimized, foam plastic was inserted in the honeycomb cores but with almost equally unsatisfactory results. Moreover, the filler, rather than acting as a buffer, was instrumental in transmitting the lateral shock pressures well into the honeycomb structure.

The NASA study noted it has been argued that most meteoric impacts will be at oblique angles and, consequently, such damage for honeycomb structures would not result. Impact tests at Ames, however, showed that even for oblique, high-speed impacts, spray particles blasted from the meteoroid bumper travel normal to the bumper rear surface. This spray is also collimated by the honeycomb, resulting in perforation.

Ames also has conducted impact tests on ablative heat shield components and found that shields impacted at space environment temperatures, when the material is brittle, show extensive damage—possibly fatal to astronauts—compared to shields impacted at room temperature. The work also indicates that mechanical fastening of heat shields exposed to meteoroid impact may be required in addition to bonding to prevent extensive shock unbonding.

● **Fiber metals promising**—Investigation of fiber metals for meteoroid protection has shown they may have many advantages over other materials, according to Frank J. Zimmerman, manager, Ballistics and Explosives branch, IIT Research Institute. Experiments showed that, for a given area density, fiber metal bumpers of varying densities were more efficient than solid bumpers in preventing damage to a target plate.

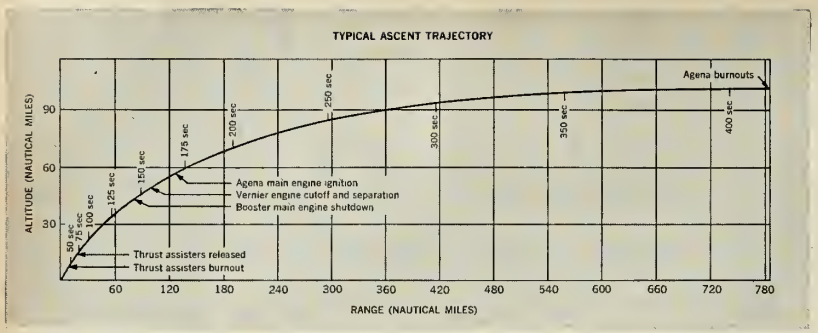
The fiber metals decrease weight while providing greater penetration protection than solid metals, Zimmerman reported. He said that although the fiber metal approach was not optimized, results show it to be competitive with conventional plastics approaches on an area density basis.

In addition, fiber metallurgy offers advantages of higher temperature capability, structural load-bearing ability, greater efficiency as a thermal sink, thinner members for equivalent weights, and greater resistance to degradation by space radiation and evaporation.

Maj. Gen. Marvin C. Demler, commander of the Air Force System Command's Research & Technology Division, said the AF Materials Laboratory has devised a novel method of self-sealing of aerospace vehicle punctures.

The method entails establishment of two spaced, impermeable barriers next to the vehicle outer wall. A stable prepolymer fluid is placed within the barrier next to the vehicle outer wall, and a polymerization fluid is placed between the two impermeable barriers. When puncture occurs, the fluids mix and solidify.

Demler said the concept had been evaluated by firing metal particles through specimens under vacuum conditions, and repeated tests have shown a high degree of successful reproducibility of self-sealing. ■



Trajectory analysis, directly affecting payload capability, is vital to any satellite flight. As Lockheed Missiles & Space Company is responsible for the orbiting of over 60% of all U.S. satellites, considerable effort has been given to the study of vehicle dynamics-performance problems.

The result: Many trajectory problems are being solved routinely through the use of automated computer programs. Some of these in use at Lockheed are: Optimal trajectory shaping programs, maximizing payload weight capability for a given set of mission parameters • Targeting programs for specific configurations, which automatically develop ascent trajectories and orbit ephemerides • Automated trajectory programs for generating dispersion analyses needed to establish propellant margins and expected injection errors • Post-flight analysis programs which establish the actual subsystem flight performance characteristics.

As missions become more complex and demanding in terms of payload capability, accuracy requirements and mission flexibility, the sophistication of ascent and orbital systems increase, demanding greater detail of trajectory and performance analysis. Engineers and scientists at Lockheed are continually expanding their capabilities to meet these needs.

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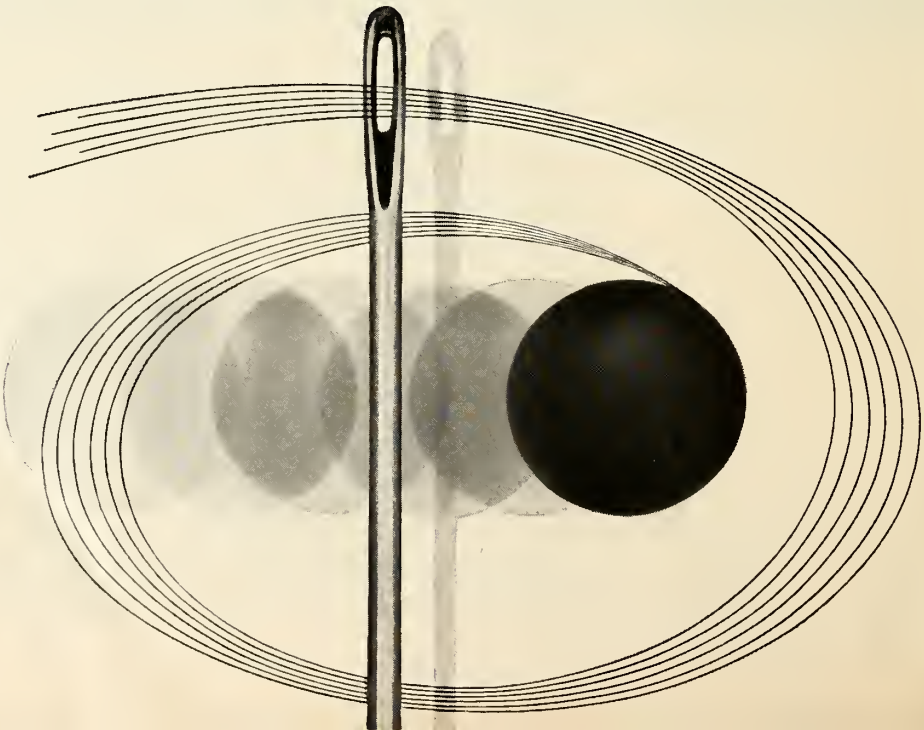
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LOOK AT LOCKHEED... IN TRAJECTORY ANALYSIS

Automation of highly complex trajectory programs



Eight Gemini Astronaut Suits Begun

David B. Clark Co. fabricating 25-lb., three-layer garments, valued at $16,000 each; zipper still presents problems

by Warren Burkett

DAVID B. CLARK CO., Worcester, Mass., has begun construction of eight flight suits for the first *Gemini* astronauts. Each man on the prime and back-up crew will get two of the $16,000 suits for flight use in addition to a training suit.

Henry Friloux, suit engineer at NASA's Manned Spacecraft Center, said recently that the suits will protect astronauts up to altitudes of 150 miles. Vacuum at this height equals 1.1×10^{-17} torr.

The 30-in. zipper that extends up the suit's back remains the weakest part of the suit, Firloux said. Oxygen at 3.7 psi leaks from the suit at the rate of 200 cc's/min. Most escapes through the zipper closure.

The rest of the suit construction appears as perfect as the state of the art permits.

● **Triple thick**—Three-layer construction extends throughout the *Gemini* suit. By contrast, flight suits for the *Mercury* astronauts, adopted from a Navy pressure suit, contained only two layers of fabric for air-pressure retention. Friloux said potential performance with the Air Force *Dyna-Soar (X-20)* suit could not be equated at this time, partly because the MSC lab had not had an *X-20* suit long enough to run comparison tests. The *X-20* suit also operates at a higher pressure, about seven psig, because mobility was not a prime factor, as it is in the *Gemini* suit.

Gemini suits weigh 25 lbs. Underneath them, an astronaut wears only a pair of long underwear. Five pockets sewn into the underwear's torso will hold biomedical amplifiers connected to sensors on the man's body. Leads from the amplifiers connect to an electrical outlet plug for the biomedical instrumentation harness. This plug is located on the left side of the chest, at about the middle of the astronaut's rib cage.

Clark constructed the inner layer of the suit—the bladder—from rubberized dacron. This bladder layer holds the air pressure. To prevent ballooning, it has been topped with a "restraint layer."

Friloux said the exact nature of this restraint layer must remain classified. It has been a prime factor in achieving a high mobility for the astronaut, even when the suit is pressurized far above the normal operating limits.

The restraint layer fits closely over the bladder layer, holding it almost against the astronaut's body. Speculation has been that the restraint layer resembles the dacron "scrim" used in high-pressure helium bubbles to confine the gas until it was needed to inflate the flight balloon section. The balloon scrim consists of plastic laced with a wide mesh of continuous fibers, like a fish net.

The suit's outer layer, made of aluminized nylon, functions mainly as an anti-snag garment, preventing the suit from hanging on any spacecraft instrumentation, controls or other equipment. The shiny surface also reflects thermal radiation and resists high temperatures (Material used: DuPont HT-1). The anti-snag layer fits loosely over the two inner layers.

None of the layers is bonded together except at the boots, zipper and biomedical harness plug, and at the two fittings for the environmental control system hoses.

Although the restraint layer controls circumferential ballooning, the suits will elongate when pressurized. Astronauts control this with an adjustment strap running from the suit's neck ring to the abdomen; this prevents the neck ring moving up around the chin when the suit is pressurized.

● **Accessories**—Boots are of the same construction as the rest of the suit. Because of this, they are soft and offer no ankle support. To stiffen the ankle, in case astronauts must land by parachute, a neoprene rubber bootee will be worn over woolen flight socks.

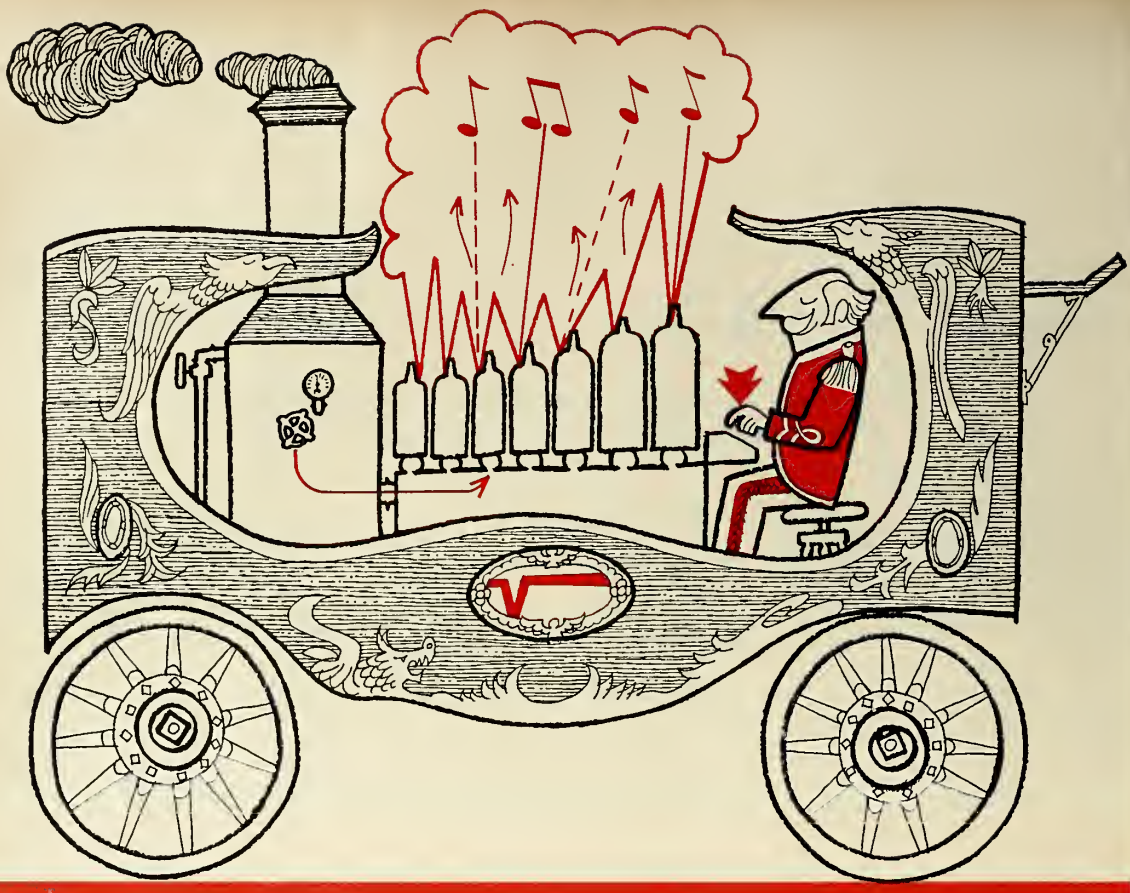
Gemini astronauts will remove only helmet and gloves during flight. Gloves will be stored in a compartment on the lower bulkhead, said Friloux. The helmet will be stowed securely by attaching it to a strip of hooked, nylon velcro. This prevents the helmet from floating about the cockpit. If the *Gemini* loses cabin pressure, helmet and gloves can be jammed onto the suit in less than three minutes. Each item can be locked onto the suit with one hand.

● **Getting dressed**—The entire suit can be donned without assistance in less than 15 minutes, Friloux estimates. Extreme care must be taken in handling the soft rubber lips that close the zipper running from the crotch up to about the middle of the shoulder blades. The rubber is very soft and can be nicked by a finger nail or impaired by dirt.

Astronauts will remove the helmet while eating and probably will keep the visor closed for comfort during flight. Better cooling results, he said, because one of the oxygen tubes blows cool air constantly over the man's face from an outlet in the neck. Astronauts will seal the visor mechanically by pulling down on a "bailer bar."

Astronauts can drink even while pressurized, Friloux said. A small pressure port above the neck ring will accept the nozzle from the drinking water tank. This feature becomes more significant in light of findings that weightlessness effects, such as orthostatic hypotension, may be accelerated by dehydration.

Larry Bell, engineer on the *Gemini* Environmental Control System, said chilled oxygen will enter the suit at about 60°F. The inlet fitting for the 1-in. hose is on the left side of the suit, just below the rib cage. Tubes from the fitting distribute oxygen to the face, hands, feet and torso. ■



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1911



FUR-SUITED Goddard engineers calibrating Low-Temperature Optical Facility for OAO.

space support

Large Space Science Satellites Get Customized Test Facilities at Goddard

by William Beller

MARKING GODDARD Space Flight Center's first major test facility hand-tailored to the needs of second-generation satellites, two optical test tanks costing $1 million will soon be putting *Orbiting Astronomical Observatories* into simulated space.

The second specialized test facility to be installed at GSFC will be a magnetic test tank for *Orbiting Geophysical Observatories*. The third such major facility is now being planned for *Orbiting Solar Observatories*.

The optical facility was built to show how well the *OAO's* are calibrated both before and after they are given shock treatments tantamount to a launch, and when they are subjected to orbital temperatures.

Under these stresses, there is also need to see if the system stays in alignment: if the light coming through the telescope is collimated and focused on the detectors; if the detectors pick up the light and accurately convert it into electrical signals for transmission through what will be a telemetry link from the *OAO's* to Earth.

● **Economics of ground tests**—As NASA becomes more involved in sending up observatories to get data on a class of space phenomena, GSFC's Test and Evaluation Div. will be spending more and more money on specialized facilities. This will be done up to the point where testing satellites in ground-based facilities will no longer be as economical as testing them, or their large subsystems, in space-based laboratories.

This point has not been reached with the *OAO's*, in which the cost of the optical facilities is only about 5% of the irrecoverable cost of an *OAO* launch. This is probably the maximum percentage cost because five or even 10 *OAO's* will possibly use the optical facilities before they become obsolete because of changes in technology. In the last instance, then, the facility cost would only be 0.5% of the *OAO* spacecraft cost.

These figures are considered well within reason for the capital equipment cost of ground-based facilities for space science work at Goddard. "We don't flinch at all with a 5 to 10% facility cost per launch for test and evaluation," said John C. New, chief of GSFC's Test and Evaluation Div. "We feel it's good management to spend as high as 20%, maybe 30%, in checking out a satellite before committing it to a launch."

New was more circumspect when asked to pinpoint where it is more economical to test a space system in its natural environment. "When it costs us about half as much to test it as it does to launch the space system, we would probably launch it," he told MISSILES

Somebody asked if UTC was in the liquid rocket motor business.



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Has developed – for future space needs – a new high-energy, space-storeable liquid fuel: Utane.

Further reference: write UTC, Sunnyvale, California

United Technology Center DIVISION OF UNITED AIRCRAFT CORPORATION

AND ROCKETS. Indicating that in any circumstance there would probably be subsystem testing, New said, "Certainly when the cost of launching spacecraft is equal to that of the testing program, there is no question."

As an example, New pointed to "our sounding rocket program where a launch might cost us $10,000 or $20,000 and we would have to spend an equal amount in testing the system. Rather than do this, we would take the chance of launching two rockets. If one failed, well, that would have been the cost of the test vehicle, but there's always the chance that both rockets would work and we'd be 100% ahead."

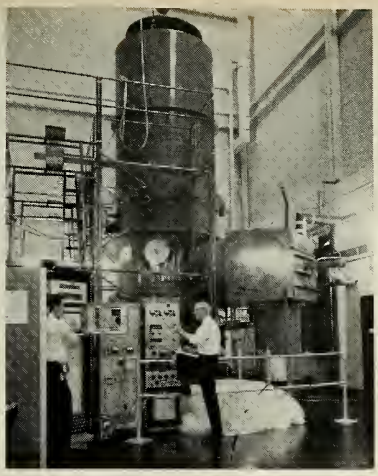
Looking at space missions other than GSFC's, New proposed exceptions to his 50% figure: "there's a different ratio when you go into some of the tasks in which you may have only one chance every few years to launch a particular interplanetary probe; or where man is riding in the spacecraft." He emphasized that he was talking only about testing unmanned equipment for scientific investigations of space.

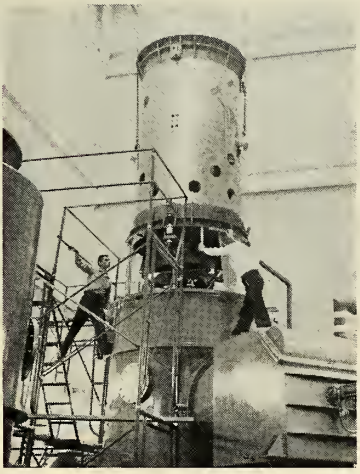
● **Tests in space**—New called attention to phenomena whose simulation would probably be too expensive to be done on Earth, if at all: "the cost of reproducing weightlessness is probably so prohibitive that we'd be better off to do it by going out in space." He said the same situation possibly exists with highly energetic particles, such as those in the solar wind. "At their energy levels, we would just go into space and measure the effects. I think that this is one of the roles manned orbiting laboratories can play."

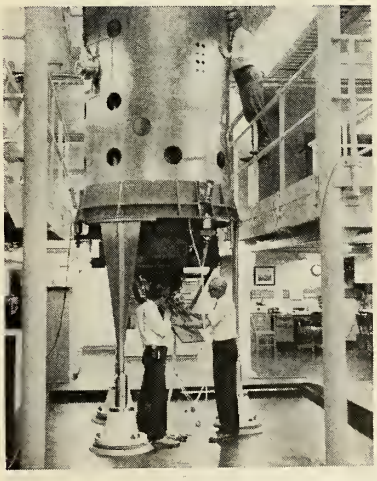
The *OAO* optical test facilities are made up of two parts: the Vacuum Optical Bench (VOB), designed to give experimenters data about the stability of alignment, calibration and performance of an optical experiment before and after it has undergone the environmental test of a launch; and the Low Temperature Optical Facility (LTOF), designed to give data about any misalignments in the optical system resulting from orbital temperatures.

The J. W. Fecker Div. of the American Optical Co., Pittsburgh, designed and constructed the VOB and the optical system for the LTOF.

● **After the launch**—The principal elements of the VOB facility are a vacuum chamber—approximately 25 ft. high by 7 ft. dia.—and a removable vertical optical bench. The bench has its own integral optical system, which includes a UV monochromator, a 38-in. clear aperture collimator, and a movable beam probe. The collimator is a Cassegrainian mirror system that directs the light, provided by the monochromator, into a 38-in.-dia. beam to the optical system under test.







TOP: Vacuum tank in background contains Vacuum Optical Bench (VOB). MIDDLE: Overhead crane lifts VOB from its vacuum tank. BOTTOM: Crane places VOB on three-legged floor stand.

With the use of an overhead traveling bridge crane, a special bench upender and other handling equipment, the entire bench, with an experiment installed, can be positioned vertically with either end up and in or out of the chamber, as desired.

The optical experiment, which is to undergo test, is mounted within the optical bench structure and is rigidly held in place on mounting lugs identical with those on the spacecraft.

The bench is capable of accepting experiment packages up to 40 in. in diameter by 120 in. long, weighing up to 1,000 lbs.

● **Cold tests**—The LTOF is a companion facility to the VOB, which is used primarily to calibrate the *OAO* experiments in the far UV range.

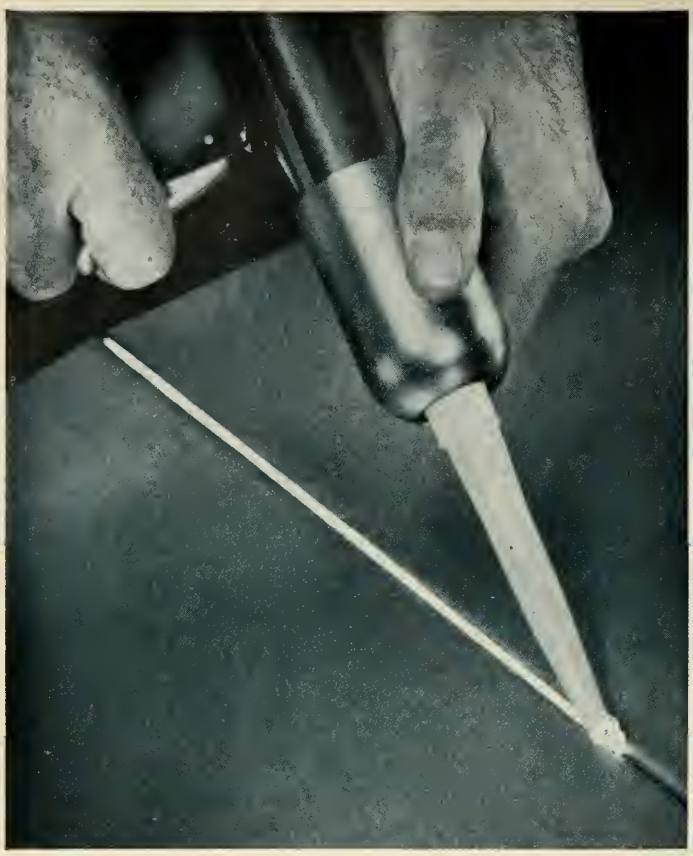
The facility consists of a controlled temperature test chamber 13 ft. wide by 43 ft. long by 7½ ft. high. Inside the chamber, but mounted on a vibration isolating block via penetrations in the chamber floor, is a 39-in. clear-aperture collimator and a special handling device. The chamber is provided with a thermal lock for personnel access at low temperatures.

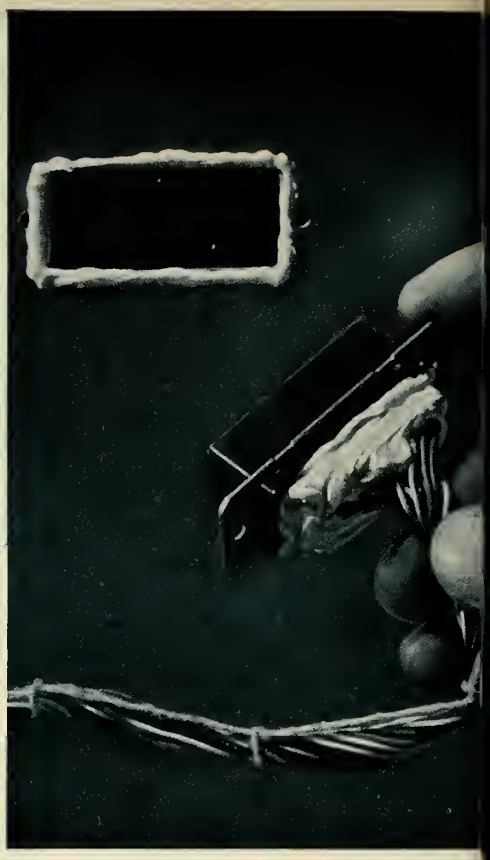
The temperature in the chamber can be varied from 23° to −60°C at a pre-determined rate. Test temperature is held to ±1°C throughout the testing area. The dew point of the air is maintained below −60°C to prevent any condensation on components in the chamber.

The collimator is a Newtonian mirror system that directs the light from several interchangeable light sources in a 39-in. beam to the optical experiment under test. The experiment reference mirror is aligned with respect to this beam by using an automatic autocollimator. The facility optical system is thermally compensated, and a means is provided for initial alignment and for checking this alignment at the test temperature.

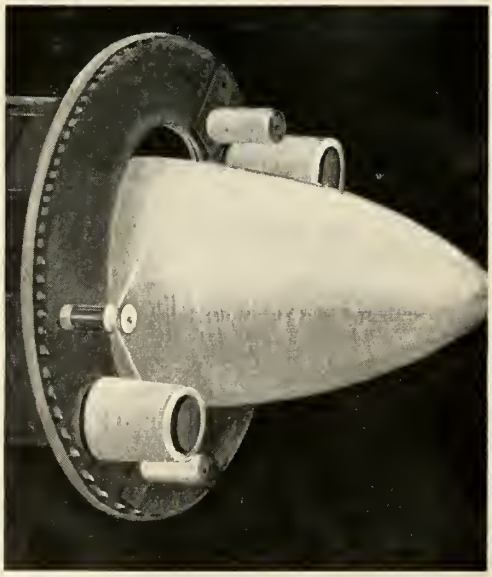
A special handling device is provided that will receive the *OAO* experiment in the vertical position, rotate it to the horizontal, transport it into the chamber and serve as a mounting structure during tests. The experiment can be rotated in pitch and yaw ±15 degrees about the geometrical center and 360 degrees about the roll axis. The LTOF will handle the same experiment packages as the VOB.

The first of four flights planned for the *OAO* program will be in 1965. System testing will go on through this year with testing of the flight article scheduled for early next year. The telescopes for the first two *OAO's* are for UV observations, while the third *OAO* will also include telescopes for X-ray observations. Plans for experiments on the fourth *OAO* are not yet final. ■





News Briefs



For structural and guidance use . . . Aerospace structural parts made of glass-laminate bonded with Dow Corning® silicone resin have a strength-to-weight ratio at temperatures from 500 to 750 F superior to that of many light weight metals. They also withstand much higher temperature levels for short intervals . . . are unharmed by thermal cycling to temperatures as low as —80 F . . . resist moisture, ozone and corrosives. Filament wound, formed, or fabricated from sheet, silicone glass laminates have many uses in aerospace including metalized reflective heat shields and motor nozzle back-up material. Good electrical properties, low dielectric constant and low loss factor over a wide frequency range are reasons for specifying silicone laminates for radomes and radar windows as well as for coil forms and component panel boards in airborne and ground support guidance and control equipment.

CIRCLE 22 ON READER SERVICE CARD

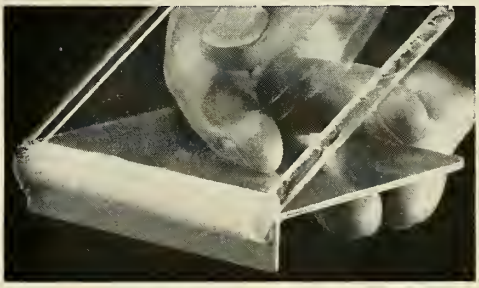
Silicone sealants, developed to meet high mach performance specifications, are easy to apply...have good adhesion

DOW CORNING® Aerospace Sealants are specifically developed to meet the needs of the aerospace and aircraft industries. This family of specification materials offers a variety of performance parameters for filleting, faying or channel sealing . . . or we can work with you in developing a material to meet your specific requirements.

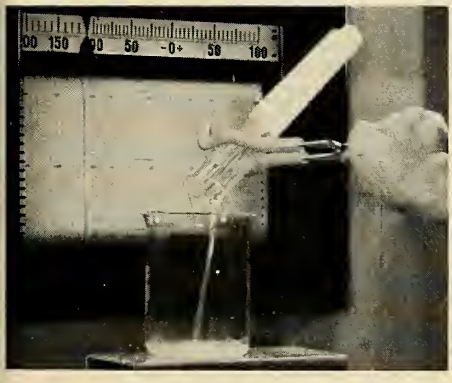
Filleting and faying sealants are silicone rubber materials that cure or vulcanize at room temperature. Typical cure time is about 24 hours. Channel sealants retain their initial plasticity for the life of the installation.

Cured sealants are resistant to the effects of weathering, aging, ozone, oxygen and moisture . . . remain flexible from −85 to 500 F . . . have good resistance to fuels and solvents . . . offer excellent electrical properties.

Easy to apply, Dow Corning aerospace sealants are supplied in cartridges or bulk for use in extrusion-type guns . . . also in collapsible tubes. Cure-in-place Dow Corning aerospace silicone sealants are tack free in one hour . . . have minimum shrink and flow. Their flexibility compensates for thermal expansion and contraction and dampens vibrations.



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For further information about materials mentioned here . . . or our capability to provide you with tailor-made materials designed specifically to meet your requirements, write Dept. 6205, or call Aerospace Materials Department, Dow Corning, Midland, Mich.

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Saturn . . . the dependable booster of the space age

On January 29, NASA's Saturn SA-5 lifted off from the pad at the John F. Kennedy Space Center carrying the first live S-IV second stage and the heaviest payload ever orbited—more than 37,000 pounds.

It thus established beyond a doubt the dependability of Saturn I, and its fitness for the key role it will play in our nation's space exploration program.

The role of the upcoming Saturn IB in the NASA Apollo program will be to earth orbit manned Apollo spacecraft vehicles for tests of the rendezvous and docking methods to be used in later manned lunar landing flights.

It is also the logical vehicle for all programs where relief from the present weight and space restrictions on payload are desired.

In fulfilling its role in the expanding national space program CHRYSLER Corporation SPACE Division—prime contractor to NASA for the first stage of the Saturn I and IB vehicles—has a continuing need for creative, experienced engineers and scientists at all levels and in many disciplines.

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SPACE DIVISION **CHRYSLER CORPORATION**

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Microminiature Welder Wins Annual M/R Competition for '63

Boeing-developed unit finishes in first place, followed by Control Data, Kollmorgen, Conductron Corp. entries

A WELDING DEVICE capable of joining wires half the diameter of human hair to surfaces only a few thousandths of an inch thick is the winner of the annual MISSILES AND ROCKETS "New Product of the Year" Award for 1963.

Electronic experts at the Aerospace Division of The Boeing Co. evolved the tool in less than a year of applied research. The microminiature welder reduces the need for highly skilled operators and cuts welding time in the fabrication of the minute circuits by 80%.

The Boeing device was selected after a careful review of hundreds of product announcements as the New Product of the Week for the issue of June 24, 1963. The annual competition pits each weekly winner with all others during the 51-week publishing year of MISSILES AND ROCKETS.

The welding unit solves problems associated with the growth of microminiaturized electronics. A typical headache is the connecting of dozens of hair-thin wires to complete electrical circuits smaller than a penny—without ruining the wire or melting another such wire only thousandths of an inch away.

Until the Boeing welder was perfected, microminiaturized electronic welding had been accomplished with great difficulty. Electrode pressure on the workpieces was erratic and the electrodes suffered deficiencies of composition and electrical transference.

The Boeing welder owes part of its success to use of a precise weld pulse. This is the amount and duration of electric energy delivered to the weld point, coupled to the electrode pressure directed to the weld.

The welder controls duration accurately from $\frac{1}{1000}$ to $\frac{1}{16}$ sec. and electrode pressure can be varied from less than an ounce to 24 lbs.

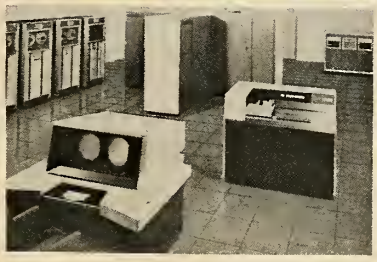
Three Awards of Honor were also announced by M/R Editor William J. Coughlin. The runners-up and their new



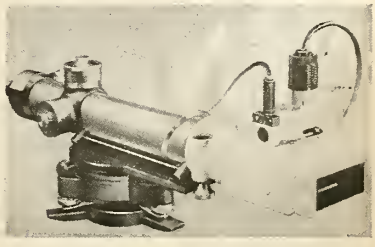
Boeing's microminiature welder.



Conductron's optical analog computer.



Control Data's 6600 computer.



Kollmorgen's pointing interferometer.

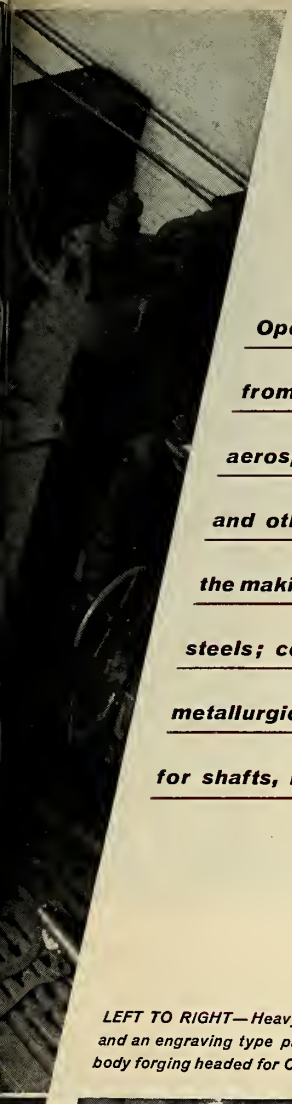
Huge forging, machined to tight tolerances, will become tailshaft aboard a Type T-5 tanker. Busy scene is in Standard's Machine Shop #2. Customer is United Maritime Corporation.



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LEFT TO RIGHT—Heavy duty freight car axles awaiting shipment to the nation's rail systems • Railroad axles, steam turbine rotor shaft and an engraving type printing roll • Pressure rolls for a ring rolling mill • Large pinion forging for a GE product • Ultrasonic testing a body forging headed for Cooper-Bessemer Company • Type 410 stainless steel domes for the thrust vector system of the Titan III program.







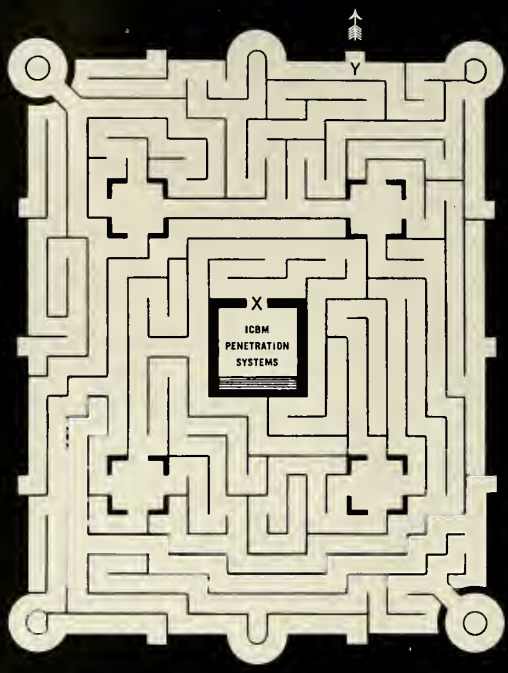
STEEL

A Division of Baldwin-Lima-Hamilton

Burnham, Pa.

BLH

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Blind alleys at every turn— *Shun them!*

Working with the Air Force to chart the course past technological blind alleys that stand in the way of the ICBM PENETRATION SYSTEMS of the future is one of the vital national-defense missions of Aerospace Corporation. Specifically:

We plan: Here—where the stakes are the future security of the nation—Aerospace is deeply involved. As a leader in the effort to devise ICBM re-entry vehicles to get through any defense, Acrospace must plan systems which can survive all efforts to stop them.

We guide: Aerospace guides the conception, preliminary design, and construction of complex ICBM penetration aids and their deployment systems. Working with the contractors for the re-entry vehicle, the booster, and the secondary payload, Aerospace must insure that the objectives of all are compatible. Aerospace also guides the assembly, checkout, and integration of re-entry vehicles and their boosters for both advanced development/research and prototype operational launches.

We probe: After a flight, Aerospace organizes data work shops in which the various contractors involved and the Air Force analyze what actually happened. Then Aerospace assembles, processes, and disseminates the information both in raw form and as final systems-evaluation reports.

We need: Engineers and scientists who welcome the demands and complexities of advanced thinking will find a stimulating environment at Aerospace Corporation. For information on current job opportunities, please write to Mr. R. E. Durant, Room 105, Box 249, San Bernardino, Calif. An equal-opportunity employer.

The problem is to find a system of repeated right and left turn combinations out of this fortress dungeon. Although there are various ways out, this system is the surest, according to *Mazes and Labyrinths, a Book of Puzzles*, by Walter Shepherd; Dover Publications, Inc., New York 14, N.Y.

AEROSPACE CORPORATION

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government

products were Control Data Corp., Minneapolis, Minn., with their 6600 computer; Kollmorgen Corp., Northampton, Mass., with the compact pointing interferometer and Conductron Corp.'s optical analog computer.

● **Big problem solver**—Control Data's 6600 computer uses silicon components with fast and simple basic circuits to reach an average of more than three million instructions per second. The freon-cooled unit will run 11 different programs simultaneously without time sharing and can serve a number of individual problems at one time.

The design approach to the 6600 signals the beginning of a new phase of computer design, according to the firm, and one in which performance will be the keynote. The computer's first application is in the U.S. Atomic Energy Commission's Lawrence Radiation Lab, Livermore, Calif.

Specifications issued by Lawrence were exceeded in the 6600, and the speed alone is more than three times the original demand.

A representative basic 6600 system will cost in the $7- to $8-million range.

● **Kollmorgen entry**—A compact pointing interferometer with a sensitivity of 0.02 arc-seconds for measuring angles up to 2,000 seconds of arc is the Honor Award winner from Kollmorgen Corp.

The Model K421 unit mounts on the Kollmorgen Model K120 or K122 alignment telescope and certain other instruments having an NAS 2.25-in.-dia. barrel.

The unit has a specially designed Koesters double-image prism adjusted to a unique zero order interference condition. The effect is a fixed Michelson inerferometer with parallel beams. Sensitivity and basic calibration are constant and permanently fixed during manufacture.

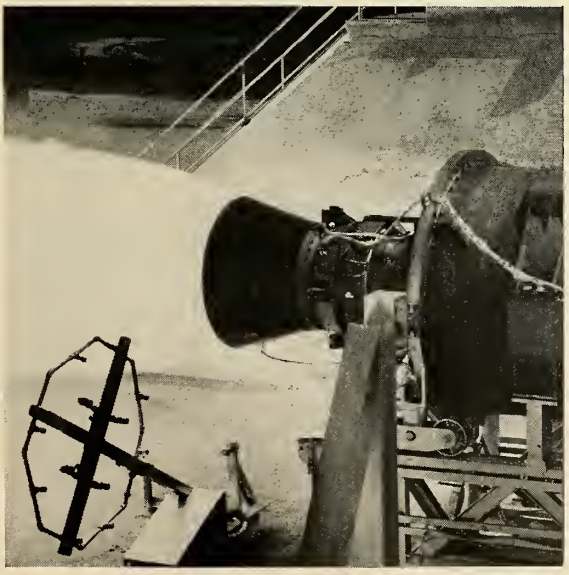
In addition to sensing the rotation of a plane mirror about an axis perpendicular to the line of sight, the device can measure the thickness of thin films, surface parallelism, refractive index differences and the homogeneity of transparent materials.

● **Optical data processor**—Conductron Corp. hit the winner's circle with its C-100 optical correlator. Based on optical analog computation techniques, the unit handles linear operations such as frequency analysis, filtering, autocorrelation, cross-correlation and a wide variety of transform-type functions such as convolution and Fourier.

More than 1,000 independent channels of simultaneous data processing are available for conventional one-dimensional processing and unique processing in two dimensions—considering two space variables.

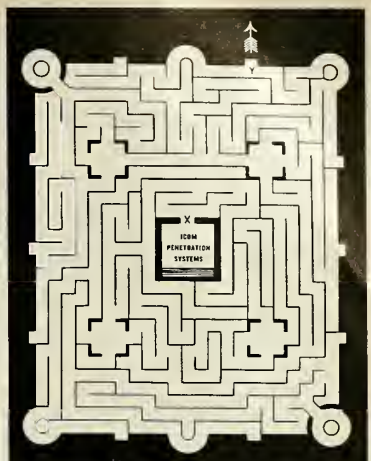
The Model C-100 is a table-top device with its source light and film-drive mechanisms operating from a 110-volt outlet. Input data are prepared on a photographic film through which a collimated beam of light is passed—the resulting light wave being modulated to represent the single channel or multichannel, one-dimensional or two-dimensional signal.

This varying light passes through lenses that perform the desired mathematical operations, and the output appears on a second photographic film. ■



Big Booster Nozzle in Second Test

A SECOND successful test firing of a subscale 156-in. TVC nozzle system at Thiokol Chemical Corp. marks the end of the test program. Firm is accelerating fabrication of the full-scale 156-in. nozzle for firing in late fall.



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AEROSPACE
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Soviet COSPAR Papers Cite Disorders Experienced by Several Cosmonauts

Part I of a two-part report on Committee meeting: Russians see possibility that ailments may be proportional to time in orbit; USSR research has grown in scope and sophistication

by Frank G. McGuire

FLORENCE, ITALY—The Soviet Union at the Seventh COSPAR meeting presented an 86-page detailed national report and a number of specific technical papers which revealed an astronaut selection and training program similar to that of the United States—while simultaneously citing several post-flight problems NASA has not had.

Although there was some redundancy and repetition of long-known information, a great amount of new material was included in the papers, which were at the conference on time, in English and in sufficient numbers. Ironically, by the end of the first week most of the U.S. papers were still locked up in Italian customs as a result of a dispute regarding their status. Dr. R. W. Porter, chief U.S. delegate, said no Italian official present at the COSPAR (Committee on Space Research) meeting had been able to break them loose.

Major revelations in the Soviet papers included:

- Disorders of the central nervous system, metabolic rate and cardiovascular system were experienced by several Soviet cosmonauts—specifically mentioned were Popovich and Tereshkova—and there is a possibility that these may be proportional with the time spent in orbit.
- A "serious decrease" in precision of small movements by hands and fingers was found during early phases of flight, but was adjusted after a time.
- Tereshkova suffered a mild eye disorder known as nystagmoid reactions during portions of her flight, in addition to being generally subdued and limited in movement. Her work load was lighter than that of her colleague in orbit, Bykovsky, and she performed all tasks assigned her despite the disturbances. Soviet scientists said she was unaware of her eye trouble but that telemetry data showed it to exist.
- The main factor in the physiological responses of cosmonauts is felt to be emotional stress—first in successfully getting into orbit, and second in getting back safely. For these reasons, said the Soviet authors, extremes of such parameters as pulse rate, respiration and similar functions are most pronounced at the very beginning and end of each flight.

All the post-flight developments, as well as those occurring during flight, were felt by both Russian and American specialists to be transient in nature, but possibly ominous for future flights if they are indeed proportional to the time an astronaut is in space.

Immediately after presentation of the key Soviet paper, a U.S. physiologist working on the *Manned Orbiting Laboratory* (*MOL*) program pressed the Russians for more details. He was partially successful, but the key questions of in-flight conditioning techniques and breathing mixtures for future Russian spacecraft went unanswered. However, some data on in-flight exercises was given in the Soviet paper.

Following presentation of the major Russian manned space flight paper by Prof. V. V. Parin, a U.S. delegate, Prof. Nello Pace, told the symposium that there is "no longer any question of success in selection and training of astronauts now that we have had 10 successful flights by both countries."

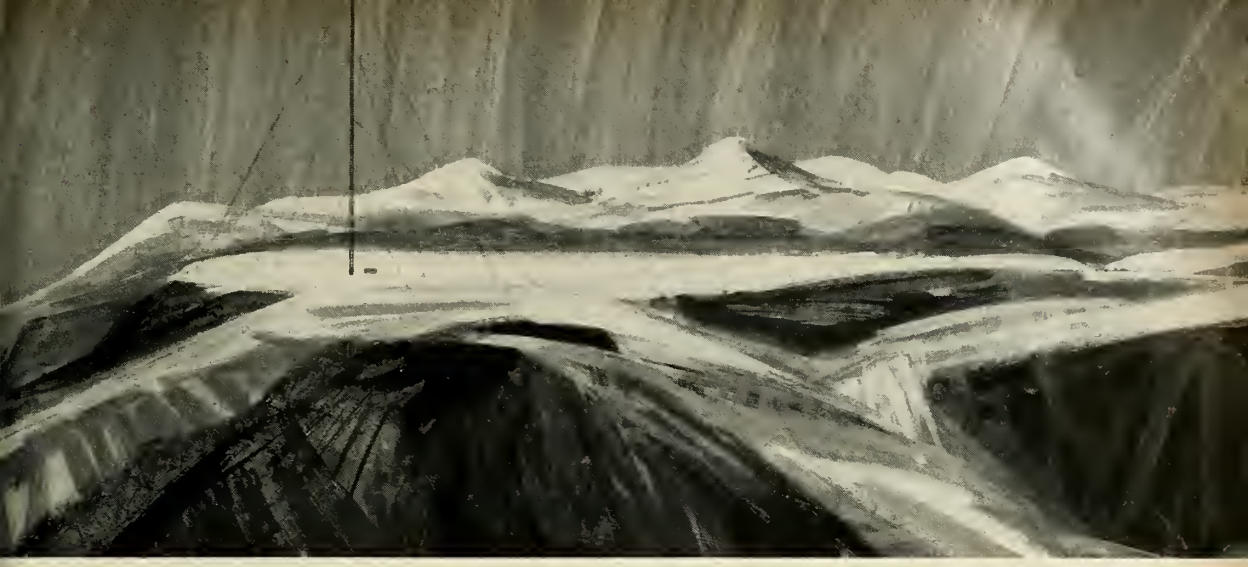
- **Post-flight disorders**—One of the key parameters measured which showed an abnormality of the central nervous system was an electroencephalogram. For Tereshkova, this showed a decrease in the cortical bioelectrical activity, expressed as a fall in both the level and amplitude of the alpha rhythm. Bykovsky, however, showed an increase in this same rhythm one or two days after the flight, described by the Soviet paper as "a marked excitation." Bykovsky's cortical reactivity—determined by the bioelectrical reaction to eye openings and closings in response to light stimuli, and by the curves of the biolelectrical activity—was lowered, the Soviet paper said. It added that 15-16 days after the end of the flight, these values were at their pre-flight level.

"Thus, the results of the clinical and physiological investigations indicated that post-flight disturbances were largely related to the central nervous system, the cardiovascular system and metabolism," the document said.

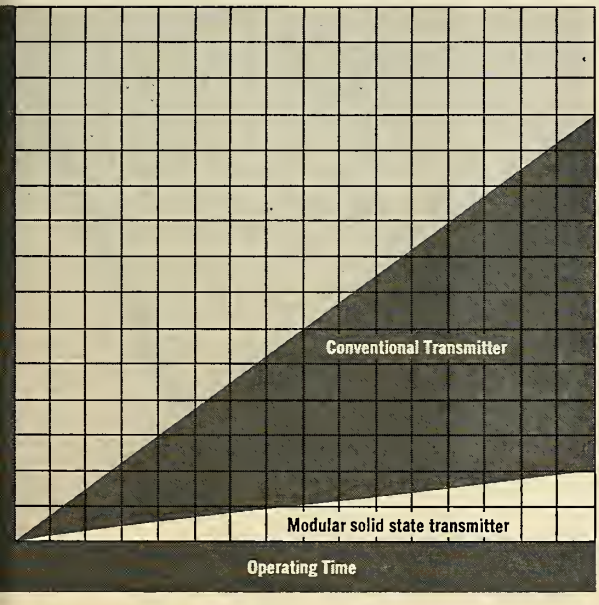
The cardio-vascular irregularities, which lasted 7-10 days after the flight, were also experienced to a much lesser extent by Gordon Cooper. Whether or not prolonged weightlessness may have an untraining effect on the cardio-vascular system, making it difficult for the system to function after a return to normal Earth gravity, is still to be determined.

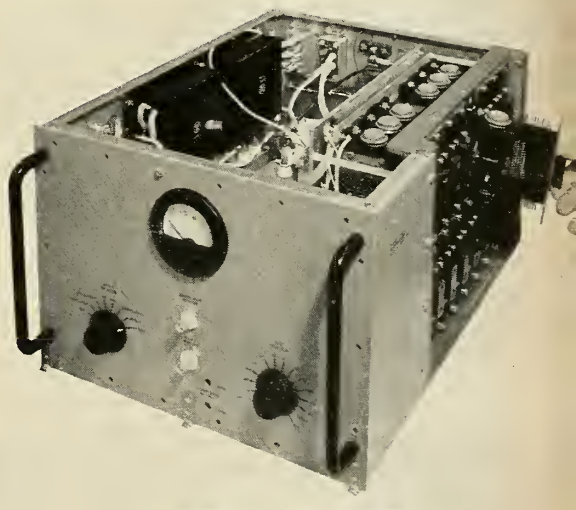
The metabolic rate increase was cited in the Soviet paper as "slight," on the basis of pulmonary ventilation and oxygen intake, but the specific figures given indicate a percentage not quite in keeping with the word "slight." Oxygen consumption by Bykovsky rose after his flight from 211 to 284 cubic centimeters, and that of Tereshkova from 172 to 230 cubic centimeters per minute. These increases are on the order of 30%.

In response to a query by MISSILES AND ROCKETS, Prof. V. Parin said the increased oxygen consumption lasted between eight and ten hours. He added later that other spacecraft breathing



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Westinghouse solid state circuits

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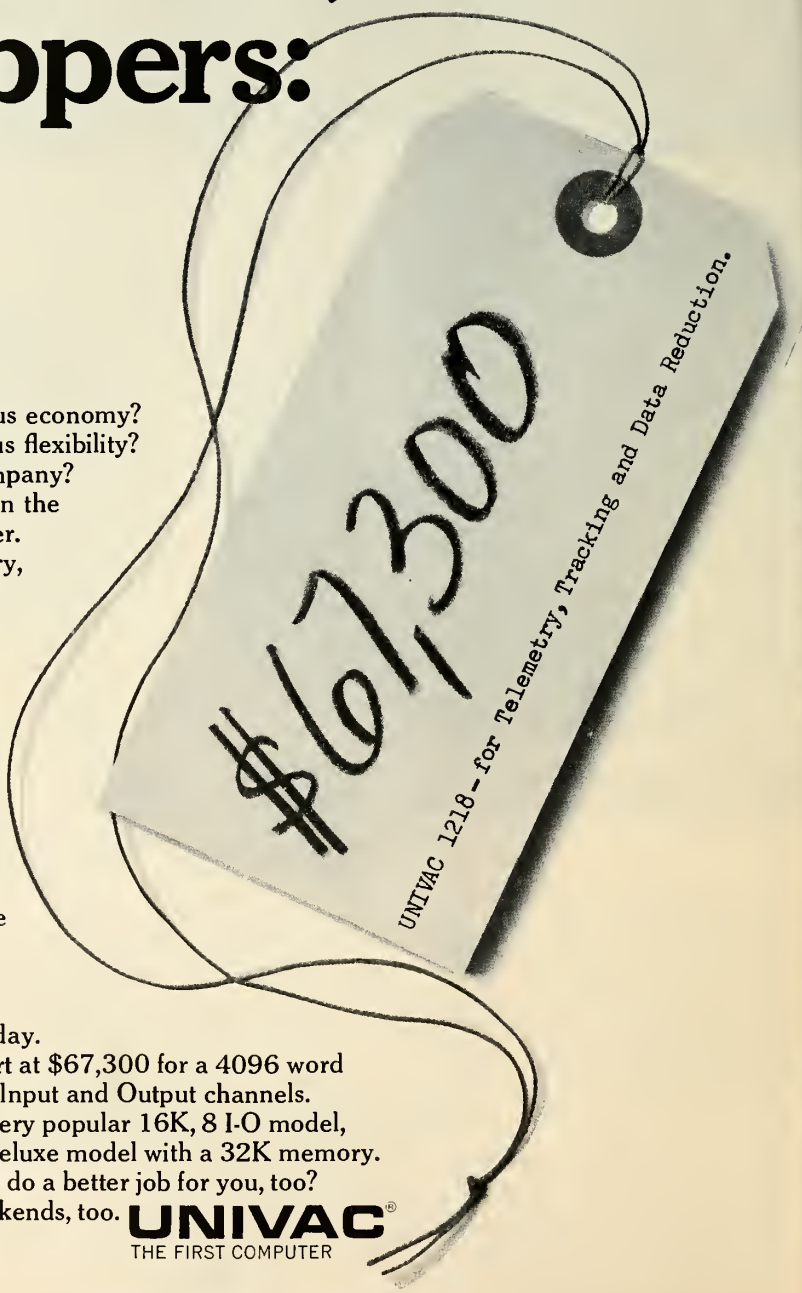
High efficiency and reliability of Westinghouse solid state transmitters permit their use in remote, unattended communications or sonar terminals. Modular design and redundancy techniques assure continued operation, at reduced power output, even if a malfunction should occur in one or more modules.

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gases besides the currently-used sea-level atmosphere were being considered, but he neither specified which mixture would be used if any changes were made at all, nor indicated in any way that a connection existed between the current atmosphere used within the spacecraft and the increased post-flight oxygen consumption. He said there was no apparent explanation for either the post-flight hypotension level or the oxygen intake rise.

The possibility that future satellites would be inhabited by animals was raised by the professor when he was asked about continuing beyond present knowledge using humans. He said the time for animal experiments is not yet past, and there may be future value in new experiments using new instrumentation.

Parin indicated that because of past findings, more specific and functional tests are now being used in astronaut selection. The man who sparked greater interest in vestibular functions, Titov, is still in the Soviet astronaut program, Parin said, but he indicated that Titov may not go into space again. Space flights subsequent to Titov's were equipped with seasickness drugs, as well as sleeping pills and stimulants, Parin said, but he emphasized that these were for emergency use only and none had actually been consumed.

In order to provide an artificial gravity, he said, rotating space ships were being studied in the USSR, although they will not be employed in the near future. He said the cosmonauts were trained in aircraft flying parabolic trajectories to condition them for weightlessness, and that centrifuge training was used for acceleration and deceleration training.

Parin described the Soviet astronaut selection and training program as quite similar to that of the U.S. Cosmonauts, he said, were isolated for various periods of time in mockups of their spacecraft to condition them to the surroundings and solitude for long periods. Preflight training in almost all respects is quite similar to that of Americans, and since practical results from both programs had been shown in 10 successful flights, neither the U.S. nor USSR should be in a hurry to make drastic changes. Pace agreed wholeheartedly.

● **Demineralization**—A theoretical threat to astronauts, one which afflicts bedridden patients a great deal, is demineralization of the skeleton due to inactivity for long periods. Under conditions of weightlessness and relatively restricted movement, it has been feared that space crewmen may suffer this danger, which is not a dietary problem. Exercising appears to be the best remedy for it, but this is not certain yet.

Parin said the USSR had obtained such data on animals, but is now receiving more complete data on the problem as it involves humans.

The paper by Parin was the highlight of the life sciences portion of the COSPAR symposium, where most papers are traditionally highly specialized. His co-authors were Yu. M. Volynkin and P. V. Vassilyev, all of the Academy of Sciences of the USSR.

The papers presented enabled top U.S. space officials to draw a number of conclusions about present-day Soviet research: it is more broadly based than several years ago, when large gaps appeared in Russian scientific efforts; hardware and techniques are much more sophisticated than was formerly the case; the USSR appears to be relaxing slightly in its fear of saying too much about what its scientists are doing; and for the first time in anyone's memory an open controversy among Soviet scientists was permitted.

Two papers concerning the ionosphere and its formation were offered. One expounded a hypothesis that the nighttime ionosphere over mid-latitudes has a negligible contribution from corpuscular ionization. A second Soviet scientist said the reverse was true, and his colleague's findings were "hardly provable." U.S. observers viewed this initial contradiction in the open as a healthy sign. Notable by their absence were rumors that a Soviet space spectacular was due any day—rumors that have flowed like a chain reaction through most previous international space conferences.

● **Soviet report**—It is quite startling to read through the Soviet national report and come upon the following sentence: "The gist of these experiments in a nutshell is as follows," for what the Soviet report says is certainly no nutshell by past standards. First detailed acknowledgements of rocket launchings which failed are listed at the end of the report; even though these involve only meteorological rockets, it is interesting that of the 110 launchings, 18 are labelled "Data not obtained." No reason is given.

Whether or not it would be valid to conjecture on Soviet hardware reliability as a result of such evidence is open to question, but a further hint along these lines is given in a discussion of astronaut instrumentation systems. This report, read to the COSPAR delegates by Academician A. A. Blagonravov, says that *Vostok 5* and *Vostok 6* had "special measures worked out for enhancing reliability of medical control systems." Further reference was made to "increased reliability of the system" in describing redundant electrocardiogram electrodes, electro-oscillogram electrodes and the use of the same telemetry channel for two physiological functions.

By inference, it may be assumed that these measures were taken as a result of trouble on previous flights, but firm evidence is lacking. One other failure of a space experiment was described in connection with satellite biological tests involving fruit flies which perished after landing due to non-flight-connected difficulties with temperature levels. No indication of reliability patterns of major space systems or boosters was given.

However, the overall impression of the Soviet report was not one of difficulties but rather that of a well-formulated and effectively executed program of research. Much of the investigation is aimed directly or indirectly at manned space flight, but other aspects have very little bearing on manned flight, being basic science apparently for its own sake.

Although nominally a report for 1963, the Soviet document covered 1964 launches as recent as April 2, when the Automatic Interplanetary Station *Sonde 1* was launched. *Sonde 1* had the objective of developing "a space system for interplanetary flights," and was sent into space from a parking orbit. Communications with the payload were carried out, the report says, and a series of program data was transmitted for purposes of mid-course guidance at a distance of 348,000 mi. Other than to say the activities of *Sonde 1* "corresponded to the prescribed program values," and that results of future investigations will be published, the Soviets gave no more information about it or its destination. *Sonde 1* is still an active payload, apparently, and will continue in use.

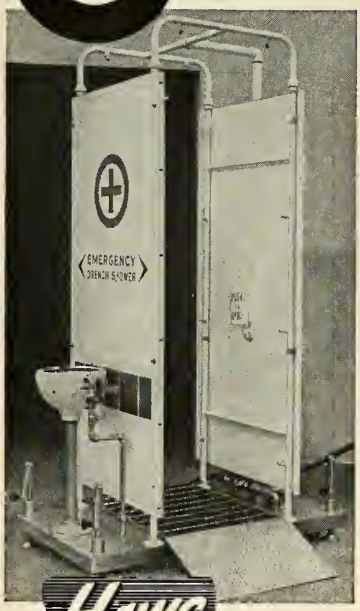
A very brief summary of findings from the *Mars 1* probe was included in the paper, mostly consisting of deep space levels of solar plasma, charged particles, cosmic radiation, magnetic fields, and similar experiments, although virtually no numbers were given in connection with this payload.

● **Electron satellites**—Probably the most comprehensive section of the report from the USSR was that on the two electron satellites launched by the same booster on Jan. 30, 1964.

Over eight pages of text and 11 pages of illustrations for these two satellites were given in the 86-page report, which devoted only 12 pages of text and no illustrations to all the biological data received from *Vostoks 5* and *6* affecting both astronauts and all other specimens. These proportions do not, however, apply to the individual papers on each subject.

A number of western observers speculated that the experiments carried out by these two satellites represent the gaps in research formerly existing in the Soviet program, and that the great

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amount of detail is considered a gap-filler. A full list of instrumentation and pbotographs of tbe instruments, satellites and findings are given.

Electron 1 is in an orbit passing tbrough the most interesting part of tbe inner radiation belt. It partially intersects the outer belt and the region of space with the irregular magnetic field, with unstable fluxes of particles causing auroras.

Electron 2 is in an orbit partly in tbe inner radiation belt, partly in the interesting portions of tbe outer belt. It intersects a region beyond the outer belt with nonstationary fluxes of electrons of low energies "wbich was called in the literature as 'tbe outermost belt of charged particles'." (Nowhere in any Soviet document do the words "Van Allen Radiation belts" appear.)

Electron 1 was placed into orbit by ejecting it from the final stage of the booster while the booster was still in operation, and using a small rocket motor to power it to tbe desired velocity and in the desired direction. Subsequently, *Electron 2* went into orbit with the final stage in a normal manner. Of the two, *Electron 1* is tbe more compact, with fewer protrusions, in order not to cause difficulties during tbe ejection phase. Following separation and injection into orbit, the extendable arms holding instrumentation and solar-cell paddles were actuated.

• **Satellite design**—On the outside of both satellites are solar cells, antenna systems, some instruments, and Sun sensors. On the cylindrical body are rotating sbutters for temperature control. *Electron 1* has solar cells on paddles; *Electron 2* has them fixed rigidly to the satellite frame.

Readings are taken at many points in both orbits, and data are stored in on-board memory devices for later interrogation by ground stations. A parallel system is used whereby direct telemetry can be obtained by ground stations of selected parameters. Both programmed and command control is used in carrying out the experiments.

Instrumentation aboard the satellites is largely identical. It includes:

Scintillation, gas discharge and semiconductor radiation detectors; detectors for soft corpuscular radiation; a beacon for investigating the ionosphere; micrometeorite detectors; mass spectrometers; various types of solar cells for performance comparisons; electrostatic spherical analyzer; magnetometers; X-ray counters; Cberenkov and scintillation counters; and normal equipment for operating tbe instrumentation.

All experiments aboard both *Electron* satellites are reportedly working normally, and a flood of data is being processed.

• **Biological findings**—One of the more interesting suggestions made by a number of Soviet authors and mentioned in the national report was tbat certain biological damage to test specimens during space fligbts may be due to stresses and vibration rather than radiation. Weightlessness was specifically mentioned as the cause of some disturbances to the mitosis mechanism.

Most central point is that during the fligbt of *Vostok 5*, Cosmonaut Bykovsky belped isolate some specimens after specific flight times, and those isolated immediately after entry into orbit were affected in the same ways and to the same extent as those left exposed to radiation for the entire five-day flight. Therefore, it seems to the Soviet scientists that exposure to radiation is not the sole factor involved in chromosome rearrangements, growth disturbances and mitosis disturbances.

In general, tbe effects of the flights were not as serious on any of the organisms tested as had been feared, and only tbe specific effects mentioned were noticed. Tbe unfortunate loss of all the fruit flies from tbe *Vostok 5* and *6* flights prevented a follow-up experiment.

Overall, tbe Russian and American scientists concurred tbat space flight, although still facing formidable obstacles, is apparently a simpler prospect than was tbought a few years ago.

• **Starfish**—In a major section of their report, tbe Soviets went back to July 9, 1962, to tbe U.S. thermonuclear explosion over Johnston Island and gave *Cosmos 5* data regarding the event, known as Starfish. Three pages of tbe report are devoted to radiation intensities before and after the explosion, and several American papers covered the same subject.

To paraphrase the Soviet description of the event, *Cosmos 5* was cruising along in orbit minding its own business and counting electrons and other things when a blinding flash lit up the sky and struck its shielded Geiger counter with "a sharp splash of hard radiation which lasted for about two minutes." At this time, *Cosmos 5* was just over the horizon about 4,650 miles from Johnston Island and not quite in a line of direct visibility to the blast, wbich took place at 250-mi. altitude while *Cosmos 5* was at 895-mi. altitude.

"This splasb called 'gama-twilight' reprcsents the registration of gama radiation connected with the nuclear explosion which occurred outside the direct visibility zone. The Geiger counter recorded in tbe main gamma radiation of radioactive products of the explosion or gamma radiation produced witbin the satellite's body and in the atmosphere as a result of nuclear interactions with neutrons which expanded in the upper atmosphere from the explosion region," the Soviet report said.



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"Delayed gamma radiation and the wave of neutrons of different energies from the explosion region experienced multiple scattering in the upper atmosphere. It is quite possible also that the part of gamma radioactive products of the explosion during the first seconds were blown out to high altitudes (above 750 mi.).

"Besides, as a result of measurements on the *Cosmos 5* satellite during the American high-altitude thermonuclear explosion of 9 July 1962, other new phenomena have been detected which were connected with the nuclear explosion. The increase of hard background radiation in low and middle latitudes was found below the region of stable radiation belts and its slow decay was measured. For the first time, positively charged particles-protons, alpha-particles, fission fragments or positrons injected by the explosion were recorded.

"Soft radiation produced in the region of the explosion and at the conjugate point have been recorded directly, in particular, electrons with energies of 50-100 kev at heights of 125-185 mi. which cause artificial aurora in the upper atmosphere."

Aside from this general picture of the effects of the Starfish event, the Soviet report gave specific energy values for electrons and other particles in the area.

• **Polyot satellites**—Brief descriptions were given of the *Polyot 1* and *2* satellites, the first of which was launched in November and the second just last month. The report merely described them as "special space vehicles which permit one to perform manuevering in the course of orbital flights." Except for saying they have telemetry, "special guiding devices and a system of engines for their stabilization and manuevering in circumterrestrial space," and scientific instrumentation, the Russian report gave virtually no details about *Polyots*. The fact that both vehicles have succeeded in performing multiple manuevers which changed both the inclination and other elements of their orbits was noted. Everything else was accomplished "according to the prescribed program."

• **Lunik 4 data**—The launching of *Lunik 4* April 2, 1963, was reported, and some technical data given on its findings. It passed within 5,300 mi. of the lunar surface, but the Soviet report failed to say precisely what the mission was, except to solve "a number of technical problems connected with the conquest of the Moon." Radiation measurements were carried out during the flight, and it was noted that "in the course of the flight the voltage of power supplies of instrumentation was kept stable with high accuracy." No other scientific results are given for the payload; it is therefore possible to conclude that the satellite consisted of nothing but a large gas discharge counter for radiation measurements and a power supply.

• **Solar flare warning**—Prior to manned space flights, an extensive network of observation stations located around the Soviet Union keep an extra-careful watch on solar activity to warn of impending flares which could cause dangerous radiation levels for cosmonauts. These readings are fed into a Scientific Coordination Center for evaluation and decision-making.

Optical, magnetic and radio observations are conducted and balloon flights carry instruments to high altitudes for further studies. These launches, conducted at various intervals of 24 hours, provided information on the penetration of corpuscular radiation into magnetic latitudes.

Shortly before the flights of *Vostoks 5* and *6*, indications were received of an impending solar flare, which developed to the level of a class-2 flare but did not actually cause any amount of solar protons to jeopardize the flights.

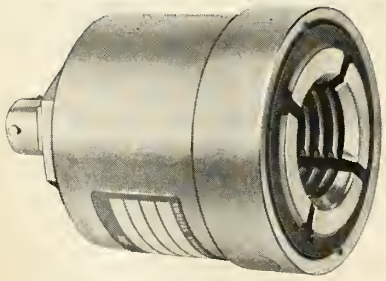
• **U.S. report**—Dr. R. W. Porter, chief U.S. delegate and a vice president of COSPAR along with the USSR's Dr. A. A. Blagonravov, read a summary of the 179-page U.S. report listing major work in the space sciences during 1963. The report was much condensed and restricted due to the impossibility of fully reporting the staggering volume of U.S. space research.

No reference was made to the *Apollo* program for this reason, and details of manned space flight included future work only as far as the *Gemini* program. Across-the-board research and development which applies to all manned space flight was, of course, included.

Briefly, U.S. launchings during 1963 consisted of: over 900 small meteorological rockets; about 100 larger sounding rockets for major scientific experiments of the upper atmosphere, ionosphere and other subjects; 56 Earth satellites, which included the last of the *Mercury* series, two *Tiros* satellites, the *Interplanetary Monitoring Probe (IMP)* payload, one *Telstar*, one *Syncom*, Project West Ford, and many others; but no lunar, planetary or interplanetary probes. *IMP* is considered an Earth satellite.

• **X-Ray sources**—Unexpected sources of X-rays were discovered during the year by a number of U.S. researchers, two of the stronger being in the regions of Scorpius and the Crab nebula. A number of uncertainties involved in the data will be the target of an experiment scheduled to be conducted during a lunar eclipse July 7. If the X-rays are sharply cut off during the eclipse it will indicate a point source for the Scorpius radiation, while a slower decline of the level will indicate an extended area of the source. This is one of the prime uncertainties, as well as definite proof that the radiation is galactic in origin. It may be that a neutron star in Scorpius is the source, or that a nebula is the culprit.

(Part II of M/R's on-the-spot report on the COSPAR meeting will cover further details of the U.S. papers and the presentations of nations other than the U.S. and USSR.) ■



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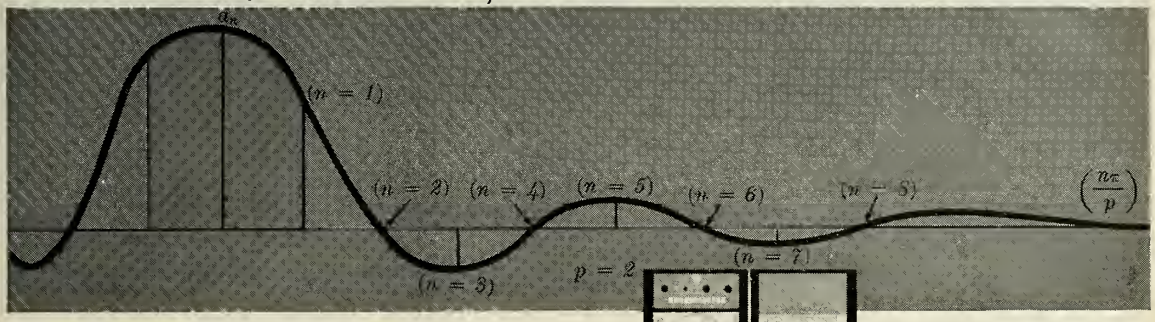
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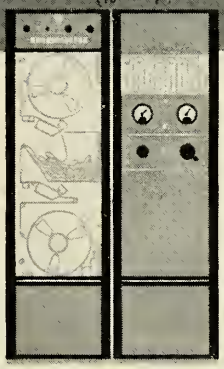
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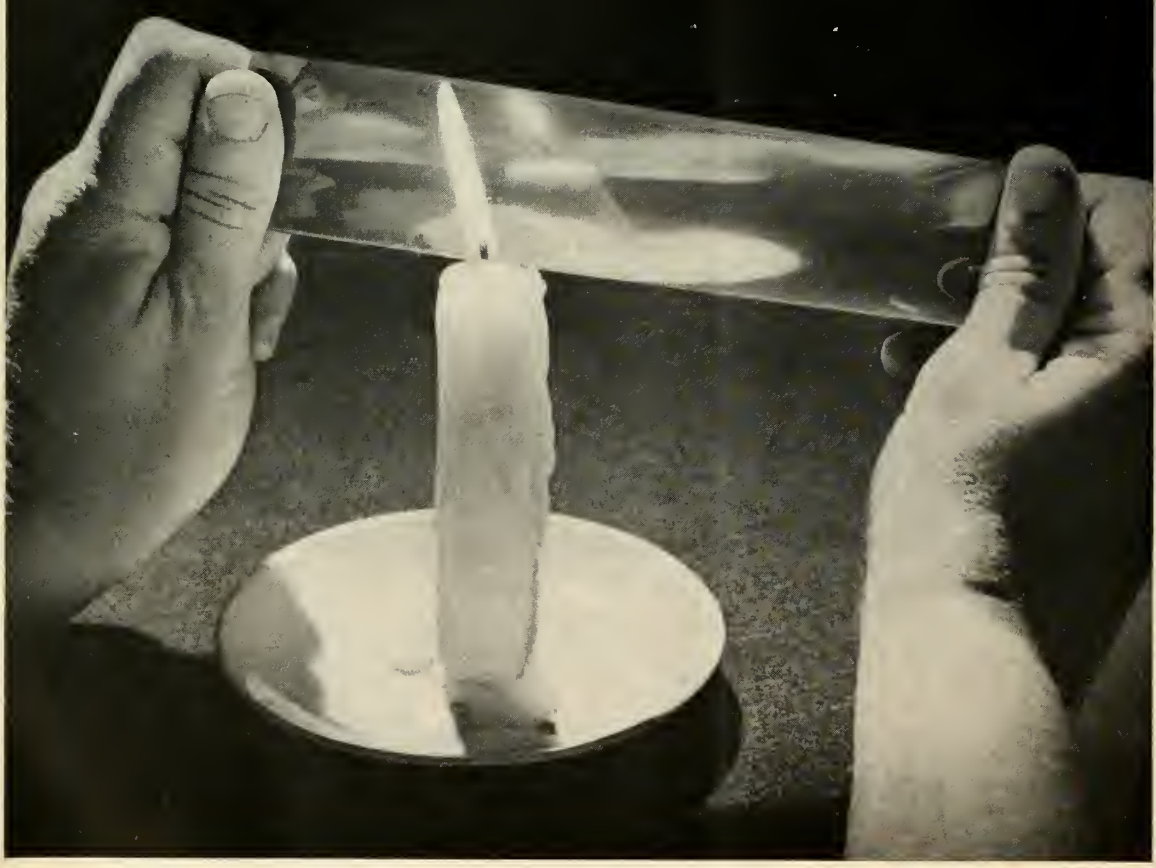
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The Industry Week

New Activities

Amphenol-Borg Electronics Corp., Broadview, Ill., has established two new activities, Amphenol Cable Div. and a Space and Missile Systems Operation. Amphenol Cable will conduct the firm's cable and wire operations, formerly a part of the company's FXR Div. The Space and Missile Systems Operation will be located in Chatsworth, Calif., and specialize in marketing interconnection components. . . . *General Time Corp. has consolidated its Advanced Electronics Group, Skokie, Ill., Laboratory, Barth Engineering Co. and the military products section of its Stromberg Div. into a new Government Products Div., headquartered in Stamford, Conn.*

Mergers and Acquisitions

Raytheon Co. has agreed to purchase Penta Laboratories, Inc., Santa Barbara, Calif., manufacturer of high-power pentode transmitting tubes. Penta will continue to operate in its present location, but as a Raytheon subsidiary. . . . *Transitron Electronic Corp., Wakefield, Mass., has purchased for cash the Phalo Corp., Shrewsbury, Mass., supplier of special cable products for the electronics and telephone industries.*

Industry Facilities

Lear Siegler, Inc's Instrument Div. is moving its executive and administrative offices from downtown Grand Rapids, Mich., to LSI's 65-acre aerospace complex in that city. . . . *Honeywell, Inc., is moving the general headquarters of its Semiconductor Products Div. from Minneapolis to Riviera Beach, Fla. on June 15.* . . . Microwave Components and Systems Corp., Monrovia, Calif., has acquired a 6,000-sq-ft. structure adjacent to its main premises. The new production area doubles the company's engineering capabilities and adds 45% to production capacity. . . . *Bowser, Inc., Chicago, is combining into one facility in Rosemont, Ill., the R&D activities of its subsidiaries, Gudeman Co., Chicago, and the Gudeman Co., California. The Gudeman companies manufacture capacitors, transformers, and delay lines for the electronics and missile/space industries.* . . . Rice University, Houston, has announced plans to build a $2.4-million Space Science and Technology Laboratory with aid of a $1.6-million grant from NASA. The facility will house the University's recently established space science department, as well as other NASA-sponsored research programs at Rice. . . . *Aero Geo Astro Corp., Alexandria, Va., missile/space electronics instrumentation firm is building five new facilities in Virginia, Maryland, Florida and California. A new building in Alexandria, Va., will be used for fabrication of a 30-ft., low-noise antenna with honeycomb construction; the College Park, Md., and Fort Walton Beach, Fla., buildings are in support of modifying and updating Nike-Ajax antenna pedestals; the Anaheim, Calif., building will house AGAC work in integrated maintenance concepts; and the second California facility, at Santa Clara, adds to existing space of AGAC's Mill-i-cast Div., which fabricates precision nonferrous castings.* . . . International Electronic Research Corp., Burbank, Calif., has opened a new plant to house its ēlin Div., which manufactures precision electronic power supplies. The new 8,500-sq.-ft. facility is adjacent to the present buildings of IERC.

International

Borders Electronics Co., Pennsauken, N. J., has been named a distributor for Evans Electroselenium Ltd. of London, producers of colorimeters, photometers, absorptiometers, electrophoresis equipment and other photoelectric scientific measuring instruments. . . . *Bourns, Inc., Riverside, Calif., has entered an agreement whereby Murata Manufacturing Co., Kyoto, Japan, will sell Bourns Instrument and TRIMPOT Div. products in Japan and Far East Asia.* . . . Long-Lok Corp., Los Angeles, has established a sub-license manufacturing arrangement with Voi-Shan, Inc., Mechelen, Belgium to cover manufacturing in that country. The new operation will join with Long-Lok Ltd. of England in making the firm's line of self-locking screws and fasteners available in the European Common Market. . . . *Greer Hydraulics, Inc., Los Angeles, has reached a licensing agreement with Nakamura Koki K.K. to manufacture and distribute Greer's accumulators in Japan.*

Company Representatives

Packard Bell Computer has named two new engineering representative firms to market its digital circuit modules and data systems equipment in the San Francisco Bay area and in the southwestern states. Dynamic Associates, Inc., Burlington, Calif., will take over the San Francisco Bay area and northern California; J.Y. Schoonmaker Co., Inc., Dallas, will cover Texas, Arkansas, Louisiana and Oklahoma. . . . *Wang Laboratories Inc., Tewksbury, Mass., has named Perlmuth Electronics as its representative covering California, Arizona and Nevada. Wang makes electronic counter units, and special analog-to-digital conversion systems, including voltage-to-digital and shaft encoder-to-digital equipment.* . . . Tracerlab, a division of Laboratory for Electronics, Inc., Waltham, Mass., has appointed the W. J. Palenscar Co., Pasadena, Calif., as sales and service representative in southern California, Arizona, Nevada and New Mexico. Tracerlab makes nuclear instruments, radiochemicals and film badges. . . . *Military and Computer Electronics Corp., Ft. Lauderdale, Fla., has appointed three major sales organizations to handle its line of magnetic components and allied instruments. They are: Beacon Electronic Associates, Inc., Maitland, Fla.; Beta Engineering Co., Minneapolis Minn.; and John W. Richardt Co., Pine Brook, N.J.* . . . Lantronics, Inc., Santa Monica, Calif., specialists in research, design, development and manufacture of microwave equipment, has named Gysan Associates of Danvers, Mass., as sales representatives in the New England area.

AWARDS

AIR FORCE

$3,600,000—**Atlantic Research Corp.**, Duarte, Calif., for work on a special test vehicle for use in re-entry vehicle studies.

$3,500,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for work on a classified project.

$2,200,000—**Garrett Corp., AiResearch Div.**, Phoenix, Ariz., for work on power units for use in space.

$1,000,000—**Westinghouse Electric Corp.**, Baltimore, Md., for work on radar equipment.

$800,000—**F&M Systems Co.**, Dallas, for instrumentation, data acquisition and control systems for the Toxic Research Facility, Edwards AFB, Calif.

$562,645—**Hallicrafters Co.**, Chicago, for production of classified electronic countermeasures and related equipment.

$237,539—**Avco Corp.**, Spaceflight Programs Office, Tulsa, Okla., for provision of radiation dosimeters for Project *Gemini* space capsules and for two unmanned AF satellites.

$100,000—**North American Aviation, Inc.**, Los Angeles, for research on families of brazed and welded fittings for rocket fluid systems.

$82,000—**Ford Motor Co.**, Aeronutronic Div., Newport Beach, Calif., for a study of thermodynamic properties of rocket combustion products.

$79,592—**Celestial Research Corp.**, South Pasadena, Calif., for a test system analysis study for propulsion research environmental chamber.

$67,733—**Thompson Ramo Woolridge, Inc.**, Tapco Div., Cleveland, Ohio, for a redesign of the 120-in. nozzle for large solids booster program.

$45,000—**FMC Corp.**, Ordnance Div., San Jose, Calif., for a study of transportation and handling systems for large solid rocket motors.

Allegany Instrument Co., Cumberland, Md., for two large rocket thrust-measuring systems for an airmunitions and propellant testing facility being built near Hill AFB, Utah (amount undisclosed).

Fairchild Camera & Instrument Corp., Space & Defense Systems, Syosset, N.Y., for basic research in advanced imaging materials for photographic reconnaissance (amount undisclosed).

ITT Data & Information Systems Div., Paramus, N.J., for a study to determine the quantity, type and format of information needed to control effectively strategic missile forces in the 1965-1989 period (amount undisclosed).

ARMY

$5,700,000—**Regents of the University of Michigan**, Ann Arbor, for materials and research services.

$1,100,000—**Arco-V Builders Corp.**, New York, for construction of a *Nike-Hercules* antimissile defense site in Florida.

$1,000,000—**Burroughs Corp.**, Detroit, Mich., for production of classified electronic equipment.

$1,000,000—**Hughes Aircraft Co.**, Culver City, Calif., for design and development of experimental hardware for launching the *TOW* missile from helicopters.

NAVY

$2,300,000—**Deco Electronics, Inc.**, Washington, D.C. for development of electronics equipment for use in communications via satellite.

$2,100,000—**Capehart Corp.**, New York City, for various electronics equipment.

$219,454—**RMF, Inc.**, King of Prussia, Pa., for missile containers.

$95,000—**D. B. Milliken Co.**, Arcadia, Calif., for 16-mm motion picture cameras for airborne tracking at the Pacific Missile Range.

NASA

$144,000—**TRW Space Technology Laboratories, Inc.**, Redondo Beach, Calif., for extended studies of the *Pioneer* spacecraft.

INDUSTRY

$38,200,000—**Martin Co.**, Orlando, Fla., from **Bell Telephone Laboratories**, Whippany, N.J., for development and testing of the *Sprint* missile.

$1,500,000—**United Technology Center**, Sunnyvale, Calif., from **Martin Co.**, Denver, for production of 85-lb. staging or separation rockets for the *Titan III-C*.

$300,000—**Electronic Memories, Inc.**, Hawthorne, Calif., from **TRW Space Technology Laboratories, Inc.**, Redondo Beach, Calif., for severe environmental serial core memory systems for deep space environments.

$270,000—**Motorola Semiconductor Products, Inc.**, Phoenix, Ariz., from **North American Aviation, Inc.**, El Segundo, Calif., for a component quality assurance program for identification of failure modes.

Bendix Corp., Aerospace Div., South Bend, Ind., from **Bellcomm, Inc.**, Washington, D.C., for a comprehensive systems study of lunar landing dynamics (amount undisclosed).

Space Ordnance Systems, Inc., El Segundo, Calif., from **Parker Aircraft Co.**, Los Angeles, for design, development, testing and production of dual reliability valve cartridges for use in the *Titan III-C* space launch vehicle (amount undisclosed).

EIMAC

Aerospace Telemetry Transmitter Excels in S Band Operation

This 2-watt transmitter uses a triode-cavity power oscillator to achieve higher overall efficiency than is possible with all-solid-state transmitters. Frequency stability is achieved by an AFC servo loop referenced to a crystal oscillator. Tuning range is 2.2-2.3 Gc. Total volume is 50 cubic inches. Modulation linearity (maximum deviation from best straight line) is ±0.5% from ±10 Kc to ±300 Kc, and ±2.5% from ±10 Kc to ±1.5 Mc. Amplitude modulation is less than 5%. Susceptibility requirements of MIL-I-26600 are met. The solid state power supply operates from 28±4 Vdc with over 80% efficiency.



For complete information on this transmitter, contact Eitel-McCullough, Incorporated, San Carlos, California. In Europe contact Eitel-McCullough, S. A., Geneva, Switzerland.

Eimac

See Eimac's display of airborne telemetry transmitters and components at the National Telemetering Conference, Booth No. 9, Biltmore Hotel, Los Angeles, California, June 2-4, 1964.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California 94035

Velocity measuring system which will be used to determine air stream velocities of 7,000 fps to 17,000 fps in arc-heated wind tunnels. RFP A-8502. Bid opening 6/5/64. Requests and accompanying specifications should be received 5/29/64.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Branch
Houston, Texas

A study to determine the effects of the lunar environment on the movement solidification and crystallization of magna. RFP MSC 64-1264P due 6/13/64.

Nike-X Project Office
Army Materiel Command
Redstone Arsenal, Alabama

The Nike-X Project Office proposes to award a supplement to an existing contract with Hudson Institute, Quaker Ridge Road, Marmon on the Hudson, N.Y., for a study on political and strategic implications of an ABM defense. Small business firms and others interested in subcontracting should make direct contact with the above firm.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

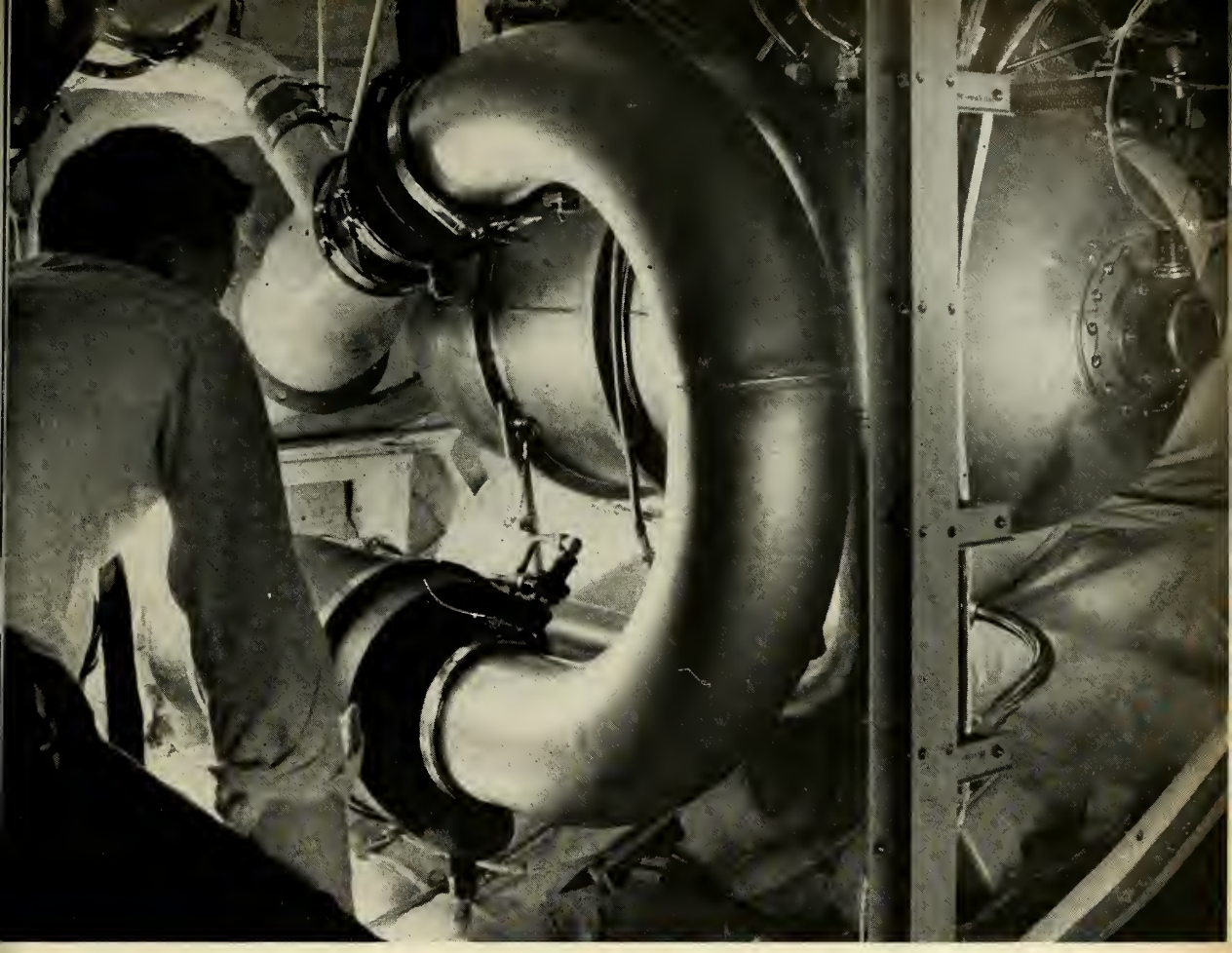
Computer control study for a manned centrifuge. RFP MSC 64-1364P due 6/5/64. Available to 5/28/64 unless exhausted earlier.

Headquarters
Space Systems Division
Air Force Systems Command
Los Angeles, California

Contract to provide 20 LV-2A and one SLV-2 space boosters to be negotiated with Douglas Aircraft Co., Inc., Santa Monica, Calif. Procurement is a follow-on to previous effort. RFP not available. For information only.

U.S. Army Missile Command
Procurement and Production
Special Contracts Division
Redstone Arsenal, Alabama

Selected source procurement with Lockheed Propulsion Co., Redlands, Calif., for a hybrid propulsion research program. This requirement is synopsized for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor.



Titanium water tank on 727 can be seen behind 6-inch titanium tubing for cabin heat system.

Pressurized Titanium tank on Boeing 727 costs less than fiberglass, saves weight

The titanium passenger water supply tank in the Boeing 727 does more than shave precious pounds at a reasonable cost. When the bids were in, titanium actually cost less than several fiberglass versions!

Boeing has found that it is worth $75 in fuel savings to slice off a pound of airframe or equipment. Both the stainless steel and fiberglass versions of the tank would have weighed 40 pounds. Titanium came in under 23 pounds.

The titanium tank cost $900. Stainless, $450. The fiberglass bids were as high as $1,300. Compared to steel, titanium saved 17 pounds at a cost of $26 per pound.

Efficient, reliable, non-toxic. Measuring 46 inches long by 18 inches in diameter, the tank operates at 125 psi internally and minus 10 psi externally. Titanium's strength and weldability made it possible to produce a tank with access doors and fittings and still retain efficient, lightweight design. The cylindrical section is rolled, welded, and has three stiffeners seam welded to the wall. Dome is deep drawn.

Other uses of titanium on the 727, include welded tubing to bleed hot engine air to de-icers . . . six-inch diameter tubing (visible in photo) for passenger heat system . . . firewalls, engine mounts . . . all told, three percent of the flyweight of the 727 is titanium.

To find out more about titanium . . . how to apply it . . . fabricate it . . . locate competent fabricators . . . write Titanium Metals Corporation of America, the nation's only firm devoted exclusively to titanium.

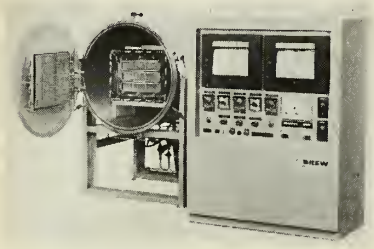
TIMET® titanium

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Circle No. 36 on Subscriber Service Card

New Product of the Week:

Heating/Cooling Furnace



Richard D. Brew and Co., Inc., has developed the Model 910 vacuum heat treating furnace, designed to provide uniform Rockwell hardness, an ability to get proper grain structure in normally air quenched materials and a pumpdown in less than 10 minutes to 10^{-5} torr range.

Specifications include: maximum temperature, 2,400°F; heat zone area, 15 x 10 x 24 in.; heating elements, molybdenum rod; power supply, variable transformer; vacuum pumping system, 6-in. diffusion pump, 50-cfm mechanical pump, pressures to 1 x 10^{-5}.

Circle No. 151 on Subscriber Service Card

Infrared Detector

Huggins Laboratories, Inc., has announced a new type of infrared detector, the ferroelectric bolometer.

A company spokesman described the device as "essentially a temperature sensitive capacitor." The sensitive element is a barium-strontium titanate ceramic that operates most efficiently at its Curie temperature of 25°C. Other operating temperatures can be obtained.

The bolometer has a spectral response of better than 80% of an ideal absorber. Detectivity exceeds 10^8 at 300 cps and the device is usable to 1,000 cps. It is packaged with a built-in preamplifier to assure optimum amplifier matching. Power requirement is 67.5v dc.

Circle No. 152 on Subscriber Service Card

Analog Programmer

Perkin-Elmer Corp. has introduced a self-contained programmer that provides adjustable function generation. The system is suited for temperature or pressure programs as well as function generation in an analog computer.

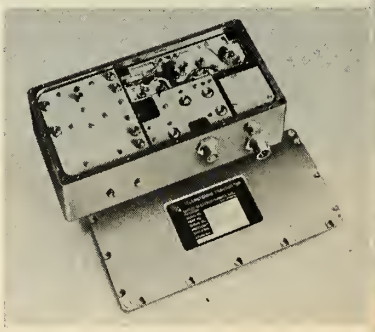
Operating from 115v ±10%, 60 cps, the programmer allows setting of empirical functions or multiple slope reversals from a 34-pole, 100-position switch. Output is plotted against a time base with accuracies of ±0.5% full scale. The device is able to display the fixed program as well as allow change of program under dynamic loading conditions.

Circle No. 153 on Subscriber Service Card

VHF Transmitter

United ElectroDynamics, Inc.'s Aerospace Div. is marketing a series of solid-state transmitters that provide 3, 7.5, and 15 watts nominal RF power in the 215 to 260-mc VHF telemetry band.

Designated TR-26, -27 and -28, these units feature FM modulation and analog



frequency response of ±1 db from dc to 300 kc, or digital data to 600 kilobits. Frequency stability to ±0.005% is available; linearity is ±1% of BSL with ±125 kc peak deviation. Operating temperature range is −20° to 85°C.

Circle No. 154 on Subscriber Service Card

Automatic Timer

An automatic timer for control of short-cycle electroplating is being marketed by Technic, Inc.

The unit's design eliminates mechanical relays, thus overcoming dangers of burn-out and sticking, and increasing reliability and operating range. The timer is available in time ranges of from 0 to 60 secs.; 0 to 5 min.; 0 to 10 min.; 0 to 30 min.; and 0 to longer periods on special order.

Circle No. 155 on Subscriber Service Card

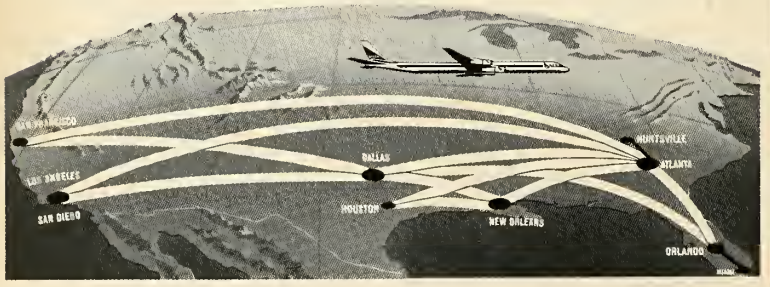
DELTA'S "Missile Express" Jets link space centers nationwide!

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MINCOM'S NEW TIDAX 1.5-mc RECORDER/REPRODUCER

The new TIDAX is a head-on approach to your problems in telemetry and general instrumentation. This high-performance Recorder/Reproducer provides a full fourteen 1.5-mc tracks in one rack —with fully automatic equalization at all speeds. Wideband FM (DC to 500 kc) is available without modification. Signal-to-noise ratio (RMS/RMS) is 25 db at all speeds. TIDAX telemetry capabilities include simultaneous post- and pre-detection recording in PCM, PCM/FM, PAM/FM, PACM and FM-type carrier systems. Mincom's exclusive DC Top Plate is rugged, simple and reliable—full dynamic braking, instant push-button speed control, tape change from ½″ to 1″ in less than ten minutes. Write today for details and complete specifications.

Mincom Division 3M COMPANY

300 South Lewis Road, Camarillo, California • 320 Shaw Road, South San Francisco, California • 529 Pennsylvania Building, 425 13th Street, N. W., Washington, D. C. • 135 West 50th Street, New York, New York • Post Office Box 272, Fairborn, Ohio • 1230 Orange Avenue, Winter Park, Florida • 2121 Santa Anna Avenue, Dallas, Texas • Eltron Engineering Sales, Inc., 246 Walnut Street, Newtonville, Massachusetts

Circle No. 37 on Subscriber Service Card



A space vehicle on its pad... a jet on the runway... or an oceanographic craft preparing for descent. The success of each mission depends largely on the reliability of support and checkout equipment. ■ Kidde produces support systems to serve these, and many other critical applications. For example, test and checkout equipment for aircraft, missiles and boosters. Functional support units to supply fluids and gases at precise flows and pressures. Operational equipment to provide functions such as pressure, flow, electromechanical and hydraulic positioning. In addition, Kidde produces simulators, servicing and maintenance equipment. ■ Kidde's many systems utilize a wide range of capabilities: Monopropellant and bipropellant technology... cryogenics... hot and cold gas valving... mechanical and electromechanical actuation. Thus, the company is equipped to design and develop custom equipments to meet the needs of space, air, and sea programs. Three such products are shown below. ■ For details, write for our brochure, "Support Systems"—Aerospace Division, Walter Kidde & Company, Inc., 520 Main Street, Belleville, New Jersey 07109.

Kidde

Portable Pneumatic Service Cart 

Hydraulic Test and Checkout Console 

Power Supply for oceanographic use 

Circle No. 38 on Subscriber Service Card

Timer-Programmer

A hardened, one-hour timer-programmer, designed for maximum reliability in telemetry and recovery systems, has been developed by Military Products Div. of the Hamilton Watch Co.

The unit is capable of completing 360 switching functions at accuracies of ±0.9 second for the first three minutes of operation and ±0.5% for the remaining 57 minutes. Operating temperature range is −20° to 160°F.

Features include a built-in circuitry for setting the programming portion of the timer at zero position; redundant starting signals from two separate power supplies, and adaptation of Junghans escapement as the timing mechanisms.

Circle No. 156 on Subscriber Service Card

Radiometer System

Edgerton, Germeshausen & Grier, Inc., is marketing a radiometer system for quantitative measurements across the optical spectrum.

The Model 580 will measure visual, photometric, photochemical and other photo effect equipments dependent upon efficient use of light/time curve responses. It handles sources from millilumen to megalumen power and energy levels and indicates the output of a steady source, a single pulse or the integrated value of a pulse train. The instrument also provides capability of scope display of pulsed light waveform signals.

Circle No. 157 on Subscriber Service Card

Decade Divider

Janus Control Corp. has available a solid-state decade divider that can be used without modification with a variety of visual displays.

The Model B100-10 is an all-silicon device that can count at rates in excess of 2.0 mc. Output is true 8-4-2-1 binary-coded decimal. The unit also features accessible test points for monitoring the BCD outputs.

Circle No. 158 on Subscriber Service Card

C-Band Parametric Amplifier

A dual-channel tunable C-band parametric amplifier designed for use in the AN/TRC-66 or a similar communications receiver is available from Airborne Instruments Laboratory Div. of Cutler-Hammer, Inc.

Specifications include a 4,400 to 5,000-mc frequency range; a 40-mc bandwidth, typical; a 3.0-db noise figure and 18-db nominal gain. Power requirement is 115v ac, 60 cps, 1.5 amp.

Circle No. 159 on Subscriber Service Card

New Ink Rectilinear Recorder for analog computer or telemetry write-out



Beckman Type SC Dynograph®

All the desirability of the Dynograph ink-rectilinear recorder, in a design for complete compatibility with analog computers

Famous Locked-In Accuracy at the tracing! Servo system constantly compares pen tip and input signal for maximum accuracy and linearity.

Reliable Solid-State Circuitry eliminates drift, component aging. No warm-up time; low total power consumption (230 w. max., for 8 channels).

- Channels: 8 analog plus event marker (standard)
- Width: 40 mm (50 divisions)/channel
- Sensitivity Range: 2.5–250 volts full scale
- Input Impedance: 1 megohm, single-ended or differential
- Linearity: ±0.25%
- Frequency Response: DC-150 cps
- Zero Suppression: 3 times full scale
- Computer Controls: "Operate," "Hold," "Reset"
- Polarity Reversal: for each channel
- Local-remote Controls: "Chart Speed," "Event Marker"
- Centralized Push Button Controls: "Sensitivity," "Paper Speed," "Calibrate," "Polarity," "Local-Remote"
- Pressurized inking system
- Paper Capacity: 1,000 ft. high gloss maximum contrast
- Paper Take-up: Reel standard, optional take-up assembly available
- Paper Drive: Zero weave, 8 or 16 speeds
- Calibration: Operate, zero, calibrate, attenuator
- Overload Indicator: each channel
- Timing Marker: one/sec or remote; second marker optional

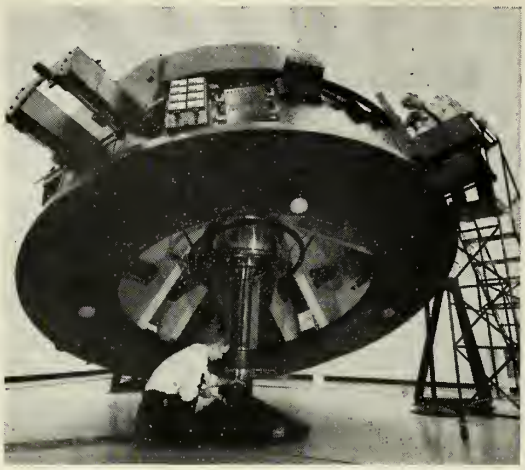
Write, or see your local Offner Representative, for Bulletin O64-1039 on the Type SC Dynograph®

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Circle No. 39 on Subscriber Service Card

WHERE RIGIDITY IS CRITICAL



The Problem: Provide a low inertia Apollo spacecraft simulation platform that can be loaded with six tons yet will not deflect more than four-thousandths of an inch at its edge.

The Solution: **Unique Bonded Honeycomb Sandwich Design by Hexcel R & D.**

Measuring 13 ft. 6 in. in diameter, the platform is shaped like a gigantic bass drum perched atop a slender pedestal. It balances upon a pressurized dry nitrogen gas bearing which virtually isolates it from friction and vibration—similar to conditions of weightless space flights. The platform is balanced so precisely that no persons are allowed in the room with it during experiments—body movements would create minute air currents which could cause the device to move in a manner unlike normal space flight.

Deflections and loads are sensitively balanced by the Hexcel design resulting in minimum overall distortion.

Thick core slabs of honeycomb (in various densities) were assembled in pie sections, sawed in the round, machined to dimensional accuracy, then bonded en masse to surface skins at room temperature using a cold-bonding process.

Hexcel R & D, under contract to Minneapolis-Honeywell, was responsible for the design, honeycomb manufacture and platform fabrication direction. Delivery was on time. Actual maximum edge deflection of the platform is .0029 in., exceeding specification.

The Hexcel objective is both to manufacture the widest range of honeycomb core products available, and to provide solutions to unusual high strength-light weight structural problems.

HEXCEL'S DESIGN OUTPERFORMS ALL OTHERS (This chart compares an earlier Hexcel Design. The platform was smaller but for the same purpose as the work discussed above.)

	Company A Design	Company B Design	Company C Design	Hexcel Design
Platform	Riveted Aluminum	Welded Mild Steel	Welded Stainless Steel	Alum. Sandwich Construction
Platform Weight	—	—	—	406 lbs.
Table Inertia Capacity	20-40 Slug Ft² Max.	26 Slug Ft² Pitch 33 Slug Ft² Roll 14 Slug Ft² Yaw	65 Slug Ft² Pitch 65 Slug Ft² Roll 33 Slug Ft² Yaw	126 Slug Ft² Pitch 126 Slug Ft² Roll 210 Slug Ft² Yaw
Max. Load Capacity	400 lbs.	1100 lbs.	900 lbs.	4000 lbs.
Deflection at Max. Load	—	½"-1"	—	.0007"-.0016"

HEXCEL® PRODUCTS INC.
World leader in research and manufacture of honeycomb core materials.
Executive Offices: 2332 Fourth St., Berkeley 10, Calif.
Plants: Berkeley, Oakland, Calif.; Havre de Grace, Md.; Irving, Texas
Sales Offices: Inglewood Calif.; Havre de Grace, Md.; Irving, Texas

Circle No. 40 on Subscriber Service Cord

Ignition Component

A new component for electronic ignition systems called the Ignistor is being produced by Bendix Semiconductor Div. of the Bendix Corp.

The device is composed of a transistor and a matched zener diode integrated into one power package. In addition to zener diode protection, the Ignistor is designated SOAR (safe, operating area) to avoid failures due to secondary breakdown. The devices are supplied in the JEDEC TO-3 and TO-41 packages.

Circle No. 160 on Subscriber Service Card

Single-Turn Potentiometer

A single-turn Vernistat ac potentiometer for use in high performance servos, analog computers and navigation systems has been developed by Electronic Products Div. of Perkin-Elmer Corp.

The Model 6R1 features a quadrature of 0.1 mv/, an input impedance of 10 K ohms at 30v and an output impedance of 100 ohms. Absolute linearity is ±0.1%. Worst case linearity for a 40-k load is ±0.18%. Resolution is 0.05%.

Circle No. 161 on Subscriber Service Card

AC Power Supply

Lincoln Dynamics, Inc., is marketing a precision ac power supply in ranges from 1 to 20 kva at 60 to 440 cps.

The unit is available under Series 2100, 2200 and 2300 designations. All units have an input of 120/208v ±10%, 3 phase, 60 cycle. Output voltage regulation is guaranteed at ±1.0%. Other specifications include a recovery time of 150 millisecs.; voltage modulation of 0.5% maximum; phase balance of 2.0% maximum; and a harmonic content of 3% on standard units and 1% on special request.

Circle No. 162 on Subscriber Service Card

Digital Transmission Units

Collins Radio Co. has developed a line of digital data transmission equipment with data rates up to twice those currently available.

The new modems, which can be built to customer specifications in terms of rates and delay tolerances, are designed for use on 3,000-cycle, 48-kilocycle and 240-kilocycle communication channels. The equipment is available in configurations utilizing 1 to 20 subcarrier tones. Maximum data rates are: 3,000-cycle unit—6,000 bits/sec.; 48-kc unit—96,000 bits/sec.; 240-kc unit—480,000 bits/sec.

Circle No. 163 on Subscriber Service Card

ENGINEERS & SCIENTISTS

What's new at Pan Am?

nothing except...

Range Support for launches of:

GEMINI
APOLLO
MOL/GEMINI B
RANGER
OAO
OGO
OSO
PIONEER
SERT
SURVEYOR
SMS
VOYAGER
SATURN 1-B & V
TITAN III
ATS
MINUTEMAN
ANNA
ASSET
BIOS
DISCOVERER
IMP
MARINER
TIROS
TRANSIT
VELA HOTEL
ETC.

New Instrumentation Systems In:

COMMUNICATIONS Increase bandwidth and/or employ compaction techniques for expanded real-time bioastronautic, telemetry, and color TV data transmission...wideband data link using communication satellites.

CW & PULSE RADAR Improve sensitivity, reliability, and accuracy of GLOTRAC, MISTRAM and MIPIR...add multiple-station slant-range measurement capability to range ships.

TELEMETRY Extend frequency coverage at all stations to 2300 mc...design a system which, upon command, will select the most important data from each station...replace obsolete AMR telemetry equipment with modern receiving and recording stations.

OPTICS Add new fixed metric and tracking metric systems to cover increased launch activity...develop a new family of standard optical beacons for installation in missiles and space vehicles...new automatic optical calibration system.

INFRARED Add new high-resolution spectrometers for launch and re-entry coverage...new IR systems to extend mid-range coverage.

RANGE SAFETY Study and develop areas of explosive hazard assessment, including instrumentation to cover chemical fuel explosions and nuclear fuel excursions.

INSTRUMENTATION & VEHICLE CONTROL Add a 64-man central control at the Cape to direct operation of the entire range...new real-time dual-system computer facility (including 2 CDC 3600's) for failure-proof high-speed data handling.

CORRELATION Reduce time correlation uncertainty across the range to less than 10 microseconds...standardize the timing signal format on the AMR to be compatible with other national ranges.

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METEOROLOGY Improve cloud height and growth indication instrumentation...develop a system to measure atmospheric electrical potential and cloud movement.

SHIP & AIRCRAFT INSTRUMENTATION Improve the instrumentation to meet more stringent telemetry, navigation, tracking, communications, and data handling requirements... phase into operation new and/or modified tracking ships and aircraft.

UNDERWATER SOUND Refine the techniques employed to establish impact location points of nosecones and instrumentation cassettes.

Selective Staff Augmentation In:

RANGE PLANNING Take projected program requirements for the next five years and develop the advanced tracking system concepts required, including instrumentation, facilities, and logistic support.

SYSTEMS ENGINEERING Develop specifications for range instrumentation systems, evaluate bids from industry, provide technical direction of development, monitor manufacture and installation, and phase systems into operational status.

SYSTEMS MANAGEMENT A new staff, not functional, group responsible for guiding the development, acquisition, and operational capacity of specific major instrumentation systems. Goal: to meet performance specifications and schedules, control costs, and achieve maximum data retrieval and handling capacity.

SCIENTIFIC STAFF A handpicked group analyzing program information and predicting system capabilities needed to support programs, using celestial and orbital mechanics, astronomy, probability and game theory.

RANGE OPERATIONS Plan, evaluate, and provide range support for all launches, coordinate all range support activities, provide data and command/destruct for range safety, and manage down-range island and ship stations.

Experience required in one or more of these areas: Pulse & CW radar / telemetry / infrared / data handling / communications / closed circuit TV / frequency analysis / command control / underwater sound / timing / shipboard instrumentation / meteorology.

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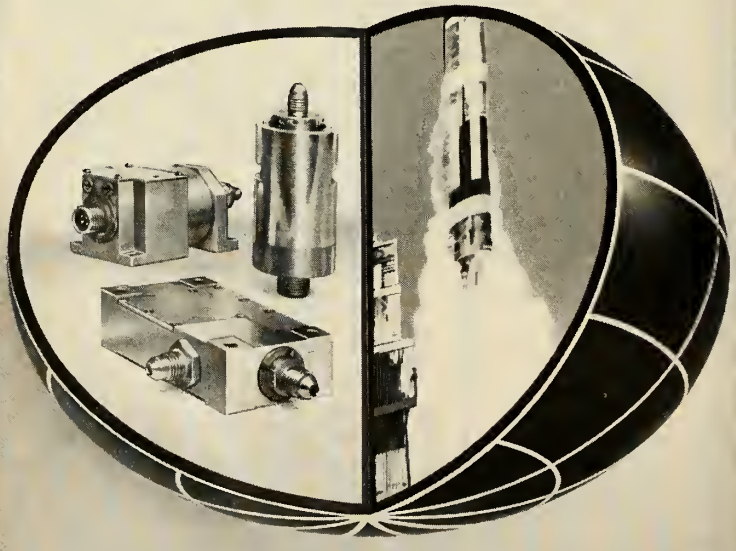
Space-proven in virtually every U.S. missile and rocket program, Wiancko pressure transducers meet the most exacting requirements for accuracy, linearity, weight, pressure range, and resistance to shock, vibration, and temperature extremes.

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Reflecting 18 years of continuous specialization in pressure instrumentation, Wiancko transducers are among the highest reliability items in the aerospace field as a matter of actual record. If your transducer application needs a thoroughbred that combines technical elegance with real stamina, these Wiancko space-pedigreed units are just what you are looking for. Get the full details from Mr. Bob Backus, Manager of Field Engineering, Wiancko Engineering, 225 North Halstead Avenue, Pasadena, California. Telephone MUrray 1-4471. A Division of Tamar Electronics, Inc.

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Amplifier

MB Electronics has available the Model 3400MB amplifier for sine, random and acoustical testing with vibration exciters.

The unit has a 4-kva power output and a 6-kw plate dissipation. This power level is available over a frequency range of 25 to 10,000 cps. Maximum voltage increases proportionately with frequencies above 5 to 25 cps. Power is available for ±10% line voltage variation.

The system has a distortion of less than 1% from 10 to 2,000 cps and less than 3% from 5 to 5,000 cps. Noise and hum are at least 70 db below full rated output.

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Digital Computer

Computer Control Co., Inc., has introduced a fully parallel, 24-bit word general-purpose computer, the DDP-224.

The device performs 260,000 computations per second. Basic memory cycle is 1.9 microsecs. with 0.8 microsecs. access time. Multiplications take 6.46 microsecs. Special options make it possible to combine several of the units into integrated large scale computer systems with functionally common or private memory, control and arithmetic.

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Mechanical Manometers

Colvin Laboratories, Inc., is introducing a line of mechanical manometers, the Series 311, to measure very low ranges.

The units are available for differential pressure ranges of 3, 6, 15 and 30 in. of water and of 0.1, 0.2, 0.5 and 1 psi. Each manometer is individually calibrated and scale errors do not exceed ±1%. Other specifications include: reliability, within ±0.7%; hysteresis, not exceeding 1.0%; friction error, within 2.0%; temperature error, not exceeding ±2.5% from 25° to −55° to 71°C.

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Millimeter Wave Isolator

FXR Div. of Amphenol-Borg Electronics Corp. is marketing the Model M157A broadband millimeter wave ferrite isolater.

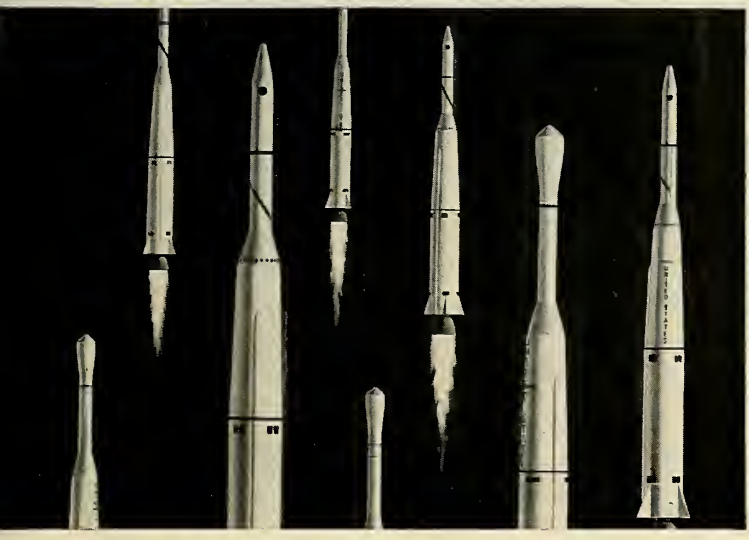
The unit, which is first in a series, offers a minimum isolation of 20 db with a maximum insertion loss of 1.5 db over the 50 to 65-gc frequency range. Input VSWR is 1.25 maximum; power is 100 mw maximum.

The devices utilizes RG-98/U type waveguide and is fitted with UG-385/U flanges. Insertion length is 2¾ in.

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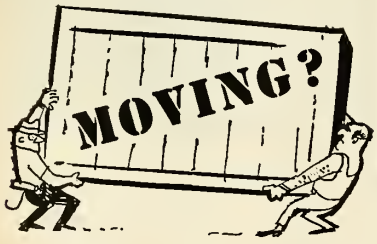
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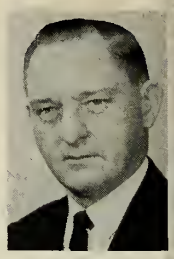
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names in the news


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HOUSE

L. Edwin Smart Jr.: Elected vice president of international operations and a member of the administration committee of the Bendix Corp., New York City.

William H. Harrison: Named vice president and controller of General Telephone & Electronics Corp., New York City.

Henry G. Tarter: Named general manager of Bendix Corp.'s Aerospace Div., South Bend, Ind.

Dr. David Miller: Appointed chief scientist of American Machine & Foundry Co.'s Advanced Products Group and director and general manager of AMF's Alexandria, Va., division.

Jack N. Veale: Named vice president of Western region marketing of UNIVAC Div., Sperry Rand Corp., New York City.

Philip H. Alspach: Appointed vice president, operations services, Allis-Chalmers, Milwaukee, Wis.

Rand V. Araskog: Named director of marketing for Honeywell, Inc.'s Aeronautical Div., Minneapolis, Minn.

Dr. James J. Renier: Appointed manager of Space and Armament Systems Dept. of Honeywell, Inc.'s Aeronautical Div., Minneapolis, Minn.

Richard M. Mock: Appointed vice president and general manager of the Industrial Systems Div., Bunker-Ramo Corp., Los Angeles.

Earl E. Dix: Named manager of TKM Electric Corp., Rochester, N.Y.

Eugene House: Named director of engineering at Cook Electric Co.'s Datastor Div., Skokie, Ill.

V. Preston Grove: Joined Lockheed Propulsion Co., Redlands, Calif., as sales manager for large solid motors.

Burt C. Allyn: Appointed manager of contracts administration for Garrett Corp.'s AiResearch Manufacturing Div., Los Angeles.

Carl B. Fisher: Appointed director of Advanced Development and Planning Center, Budd Information Sciences Center, Arlington, Va.

Philip S. Montgomery: Named sales manager for the Dayton, Ohio, region for the Aerospace Div., Walter Kidde & Co., Inc., Belleville, N.J.

James E. Lindsay: Appointed head of engineering and development activities of the new precision gauge division of Roylyn, Inc., Glendale, Calif.

Wallace C. Leedy: Appointed manager of training and development at ITT General Controls, Inc., Glendale, Calif.

G. T. Willey, vice president and general manager of Martin Co.'s Orlando, Fla., division, has received the Air Force Systems Command Award for Outstanding Achievement.

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Col. Edward J. Arakelian, USAF (Ret.): Joined TRW Space Technology Laboratories, San Bernadino, Calif., as a member of the Technical Planning Staff.

John J. Crowley: Named director of the new Redeye Systems Management department of General Dynamics/Pomona, Pomona, Calif.

Dr. Henry F. J. Wigton: Joined Molectro Corp., Santa Clara, Calif., as head of materials research.

Thomas L. Snowdon: Named marketing director of Electronic Components, Speer Carbon Co., St. Mary's, Pa.

Stanley W. Meyer: Named manager of quality control and customer technical service of the Memorex Corp., Santa Clara, Calif.

Richard E. Freese: Promoted to vice president-treasurer of Pesco Products Div., Borg-Warner Corp., Bedford, Ohio.

Charles L. Ill: Promoted to head Page Communications Engineers, Inc.'s Marketing Executive Directorate, Washington, D.C.

William A. Jones: Named general manager of the military electronics division of Loral Electronics Systems Corp., The Bronx, N.Y.

Joseph R. Greer: Appointed general manager of Explosive Technology, Inc., Santa Clara, Calif.

Joseph D. Zasa: Appointed assistant director of marketing at Bendix Corp.'s Bendix Systems Div., Ann Arbor, Mich.

Seymour Schoen: Appointed director of the computer systems laboratory at the Guidance and Control Systems Div. of Litton Industries, Woodland Hills, Calif.

Neil E. Billman: Appointed distributor sales specialist for General Electric Co.'s Silicone Products Dept., Waterford, N.Y.

George B. Achtmeyer: Appointed director of manufacturing for the Sperry Gyroscope Co., Great Neck, N.Y.

Edwin D. Kaiser: Appointed vice president of marketing by Radar Design Corp., Syracuse, N.Y.

Julian H. Ray: Elected president and chief executive officer of Washington Technological Associates, Inc., Rockville, Md. **Dermot Nee** named chairman of the board.

Harry E. Criner: Appointed engineering manager of the DeMornay-Bonardl Div. of Datapulse, Inc., Pasadena, Calif.

Samuel E. MacArthur: Named vice president-corporate planning at Federal-Mogul-Bower Bearings, Inc., Detroit. **Thomas F. Russell** promoted to director of finance and **Ernest W. Anderson** has become treasurer. **Donald R. Potter** promoted to director of trade relations.

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high coupling stiffness: the direct drive torque motor is attached **directly** to the load itself — therefore no gears, no backlash errors, no mechanical resonant frequency problems.

fast response: since it produces higher torque for its size than any other electromagnetic device, and since its torque is a direct function of applied current independent of speed (a function of voltage), the torque motor's response is absolute and instantaneous at all operating speeds.

high resolution: the same characteristics that result in fast response from stand still to maximum operating speeds result in "locked-on" resolution. The torque motor is limited only by the sensitivity of the error sensing circuits that command it.

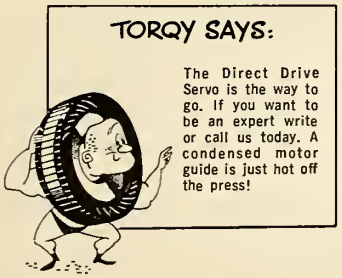
high torque-to-inertia ratio: a direct drive motor has the highest practical torque-to-inertia ratio. To respond to an input signal, it must overcome only the inertia of its own, slowly turning rotor and the driven load. Since it is directly coupled to the load, it has no gear train. A gear train increases inertia by a multiple equal to the square of the gear train ratio, resulting in sluggish response.

compact, adaptable design: small, pancake configuration allows fitting the motor into minimum spacing around or on the end of the shaft to be driven. It is ideal for applications where minimum size, weight, space are required and only minimum power is available.

high linearity: torque increases directly with input current, independent of speed or angular position. Electromagnetic linearity through zero excitation assures smooth operation and sensitivity to input signals.

reliability and long life: the basic simplicity and absolute minimum of moving parts makes a torque motor inherently reliable. Extensive design and production experience have put Inland torque motors in most major defense programs of the last decade. These include widely ranging applications under all conditions and environments from thousands of feet underwater to years of unattended operation in outer space.

Inland Motor Corporation specializes in direct drive torque motors and servo subsystems. Having originated most of the designs available today, Inland makes available a design library of over 600 torque motor models. Catalog items range from a small 0.03 lb-ft motor to those capable of 3000 lb-ft of torque. A new modular unit now in design will produce over a million lb-ft. Inland also manufactures rotary and solid state amplifiers, tachometer generators and other units which give Inland the unique capability to design and deliver complete direct drive servo subsystems for positioning, rate and tensioning applications. Inland's experience, production capacity and complete prototype facilities are distinct advantages to the customer.



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—when and where—

MAY

First Annual Symposium of the Subcommittee on Research and Development Contracts, Committee on Government Contracts and Procurement, Federal Bar Association, Waldorf-Astoria Hotel, New York City, May 25.

Aviation/Space Writers Association Annual Conference and News Meeting, Americana Hotel, Bal Harbour, Miami Beach, Fla., May 25-29.

International Electrical Industry Show, New York Coliseum, New York City, May 25-27.

JUNE

10th National Analysis Instrumentation Symposium, "Advances in Analytical Instrumentation for Measurement and Control," Instrument Society of America, Sheraton-Palace Hotel, San Francisco, June 1-3.

National Telemetering Conference, AIAA, IEEE and ISA, Biltmore Hotel, Los Angeles, June 2-4.

National Symposium on Global Communication (GLOBECOM VI), IEEE, University of Pennsylvania and Sheraton Hotel, Philadelphia, June 2-4.

Society of Plastics Engineers Meeting on Stability of Plastics, Sheraton-Park Hotel, Washington, D.C., June 4.

Electromagnetic Window Symposium, sponsored by Atenna Laboratory Dept. of Electrical Engineering, Ohio State University, and Research and Technology Div., USAFSC, Columbus, Ohio, June 2-4.

Symposium on Quasi-Optics, sponsored by Polytechnic Institute of Brooklyn, IEEE, U.S. Army Research Office, U.S. Air Force and U.S. Navy, Statler-Hilton Hotel, New York City, June 8-10.

Seminar on "Computer Applications to Structural Engineering," IIT Research Institute, Chicago, June 10.

Systems Engineering Conference and Exposition, New York Coliseum, New York City, June 8-11.

Sixth National Electromagnetic Compatibility Symposium, IEEE, Los Angeles, June 9-11.

National Electronic Packaging Conference, New York Hilton Hotel, New York City, June 9-11.

Eighth Annual Product Engineering & Production Conference IEEE, Pratt Institute, Brooklyn, N.Y., June 11-12.

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The Rise and Fall

THERE IS A YAWNING trap faced by most technical and science writers when they attempt to tackle broader subjects, particularly those with political overtones. This is a tendency to oversimplify the political factors, to see them in the black and white of scientific logic rather than in the muddy brown and gray of illogical, human everyday life.

The world with which you are unfamiliar appears much simpler than the complex one of which you have intimate knowledge. This is the trap which engulfs the writer of a just-issued volume of great interest to the missile/space industry.

Yet this new book—"The Rise and Fall of the Space Age," (Doubleday and Co., $3.95) by Edwin Diamond, a senior editor of *Newsweek* magazine—is one of the most factual to date on the still-young Space Age. It is all too rare to find such attention to accuracy in a book on space.

Mr. Diamond, in his acknowledgements, concedes his debt to Henry Simmons of *Newsweek's* Washington bureau, known in the capital as one of the most penetrating reporters in the missile/space field. Both Mr. Diamond and Mr. Simmons have a reputation for thoroughness and accuracy in their reporting.

It is with regret, therefore, that we take exception to all of Mr. Diamond's conclusions—a stand that will come as no surprise to him. We should say at the outset, however, that this meets our definition of an excellent book, one in which you can accept the facts and disagree with the conclusions. Mr. Diamond clearly distinguishes between the two.

His political oversimplification is carried to such an extreme that the interplay of forces between the Soviet Union and the United States appears to be conducted on the level of a grammar-school playlet. This complex relationship is reduced, in Mr. Diamond's view, to "we did this, therefore they did that, and we then did thus-and-so."

Mr. Diamond sums up the philosophy of his book in the closing words of his first chapter: "It is not inconceivable that the United States and the Soviet Union, two nations who disagree about so much on Earth, can find common cause in space. The idea requires getting used to, mainly because so many myths and misstatements have grown to encrust the Space Age in its short span of existence. The following chapters are an attempt to scrape away some of the legendary material."

Mr. Diamond then proceeds in his effort to get us used to the idea.

The *Newsweek* editor opens his case by asking us to believe that the launching of *Sputnik I* really was the end-result of an enormous mistake by the Soviet Union—that it was, "for those knowledgeable enough to decipher the evidence, a sign of Soviet military weakness rather than strength." The misreading of this evidence, he contends, resulted in an arms race which neither side really wanted.

Just how this conclusion jibes with the fact that the Eisenhower Administration gave the ICBM the highest national priority in 1954, several years before *Sputnik I*, the author fails to explain.

Like others before him, Mr. Diamond tells us the Missile Gap was a myth. Like others before him, he overlooks the fact that the potential Missile Gap would have become a reality in favor of the Soviet Union but for the step-up in U.S. production. This distortion of reality with the convenience of hindsight appears throughout the book.

He draws the conclusion that the two great powers got themselves into a missile and space race that neither side really wanted, or wants. This was the shaky base on which the rise of the Space Age was built, we are told.

Now that the U.S. and Russia have come to their senses and seen the warm reality of Mr. Diamond's international understanding, the Space Age is on the decline. So he would have us believe.

"Finally, for the first time since the cold war began, the path to real peace has opened. The shift away from first-strike weapons, the high cost of new weapons systems, the unwillingness of either the Soviet Union or the United States to continue the arms race in space, are all signs that the time for arms control and disarmament may be near." Thus, Mr. Diamond opens the golden door to that era of peaceful cooperation in space when the Space Age again will be on the rise.

"Yes, there is still time to right the dream," he tells us. "Most of the troubles are in the controls, and man has the power to set them on the proper course again before the opportunity is irretrievably lost."

Bunk. If Mr. Diamond turned in that kind of schoolgirl philosophy to his editors at *Newsweek*, they would throw it in the wastebasket where it belongs. He obviously doesn't have such a discriminating audience to please at Doubleday.

THERE IS MUCH OF INTEREST and entertainment, however, in Mr. Diamond's course toward his tortured conclusions. Enroute, he manages to reduce the growth of the space market to sheer speculation, demolish any notion of a separate missile/space industry, bring the fallout of space technology down to the level of filament-wound brassieres, take resounding swipes at *Life* magazine, the astronauts, Lt. Col. "Shorty" Powers, television and just about everything connected with the Space Age, with the exception of *Time* magazine, which for some reason he ignores.

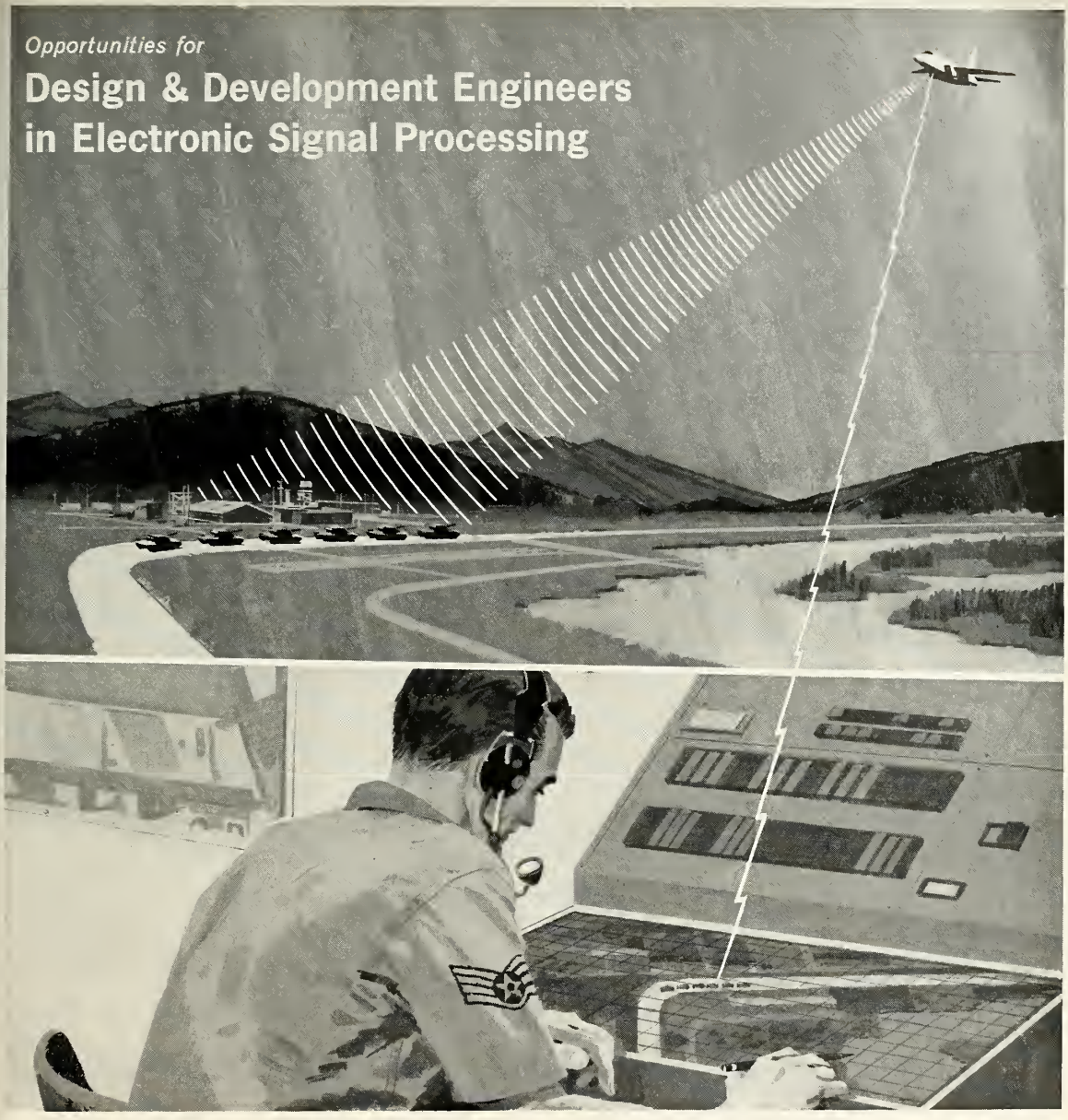
We belong to what Mr. Diamond calls the counterforce school of strategy and agree with former Air Force Chief of Staff Thomas D. White in his philosophy that "only by striving for continued military superiority" can the nation hope to survive, a remark with which Mr. Diamond obviously disagrees.

Nevertheless, we think you should read Mr. Diamond's book for a view of what the Space Age looks like through hemlock-flavored glasses.

William J. Coughlin

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

JUN 1964
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Special Report: Electro-Optical Systems

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Major Gains in Hybrids Reported

Schriever Lauds Materials Advance

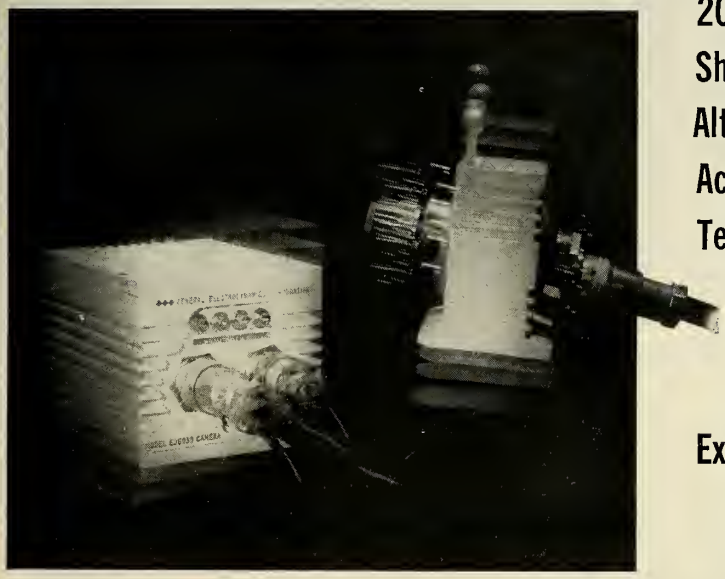
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Volume 14, Number 22 June 1, 1964

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THE COVER



Kodak laser rods, made of neodymium-doped rare-earth glass, are tested on a gas laser interferometer. Beam from the helium-neon gas laser passes through and around glass laser rod to a flat mirror at left. Some of the beam also hits a flat mirror at top and reflects back to the microscope eyepiece. M/R's special report on electro-optical systems begins on p. 23.

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SPECIAL REPORT: ELECTRO-OPTICAL SYSTEMS

Compiled under the direction of Senior Editor Charles D. LaFond

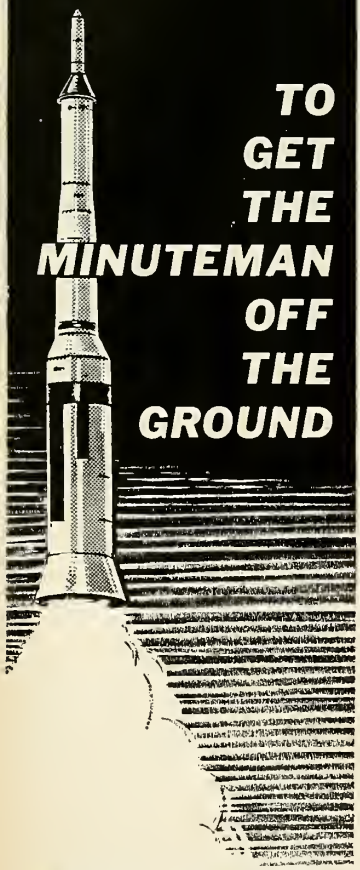
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letters

Bombers, Si, But . . .

To the Editor:

In answer to J. F. Newton's letter (M/R, May 18, p. 7), in which he claims manned aircraft to be necessary because missiles cannot "see." His position implies that manned bombers can choose targets while flying in the grass at Mach 2.2.

I believe command posts and communications centers about which we have insufficient target information to be concealed from aerial vision. Furthermore, if mobile launch sites could be found, they would probably be empty by the time our bombers reached the target area.

I agree that there should be a "mix," but not for the reasons cited by Mr. Newton. Our manned bombers are extremely valuable to our defense because they enable us to maintain a proven, powerful, intelligent nuclear deterrent at various stages of readiness all over the globe. Manned bombers will be obsolete only when their successors can achieve the same paralyzing effect on our enemy's ambitions.

William Castellano
Berkeley, Ill.

Combustion Instability

To the Editor:

A recent communication on the subject of axial combustion instability (M/R, May 11, p. 4) deserves some comment, as it references a portion of the earlier work in this general field by scientists formerly associated with me.

Many conflicting statements have been made over the years on the relationships between erosive burning, unstable burning and propellant composition. Consequently, when the Canadian large rocket program was instituted in 1955, certain key studies were planned in the hope of eliminating costly cut-and-try development approaches. The techniques developed, such as pulse rating, enabled a reduction of some significance to be made in the number of rocket motors needed to carry out a static proving trial. Of almost greater interest to me was the feed-back obtained on the way compositional factors appeared to affect certain ballistic characteristics. While the results were obtained from the study of a very limited number of propellants, I judged them to be of some importance and proposed a more detailed investigation. The embryonic ideas were subsequently presented at the AGARD Combustion Colloquia in April, 1962, (L. A. Dickinson and F. Jackson, "Combustion in Solid Propellant Rocket Engines").

It is indeed most gratifying to learn from your correspondent (Mr. I. R. Cameron) that these early concepts were as useful as I predicted. The data being gained from their continued study in the Canadian program would appear to follow the anticipated pattern and suggest that other propellants be studied. In our own current investigations, involving a wide range of propellants, many new and interesting conclusions are being reached. The question of transverse instability was also raised by your correspondent. In answer, I would say that coupling of modes is an established fact and it is felt that results indicate that the one should not be studied to the exclusion of the other.

In conclusion, I must state that the original article ("SRI Composition Formulations Control Combustion Instability in Solids," by Willard E. Wilks, M/R, March 9, p. 36) aroused a great deal of interest among your readers. Should any questions remain to be answered in the mind of your correspondent, or that of any other reader, I would be most pleased to answer them by direct correspondence.

Lionel A. Dickinson
130 Fawn Lane
Portola Valley, Calif.

Milestones & Millstones

To the Editor:

The article, "Steam Concept Interests Air Force" (M/R, April 27, p. 24) only serves to point out the standard and all-pervading incompetency of the Air Force in the fields of technical management, research and development. Anything exotic, impractical and expensive, and which requires a lot of development is just what the "geniuses" in blue need. Anything simple, cheap, and practical is looked at with a jaundiced eye.

To say that Dr. Whipple's paper finally woke someone up is a feather in his hat. He has published many papers on meteoroids and micrometeoroids over the years (his Harvard College crews have been at work in this field for years) and I am sure that this same information was available long before the "fateful" day in January, 1963. Indeed, not only he but Manning, Villard, Eschelman, et al at Stanford University have also published innumerable papers on meteoroids, with figures on size, numbers, and so on.

When those in the Air Force—and NASA, and others in the government—learn that the sum total of human knowledge and ability does not rest in their hands; when they learn that the basic sciences were developed long before they appeared on the scene; when they learn that they cannot re-invent thermodynamics or physics, or—most of all—common sense, then we will have indeed reached a milestone. Now, instead of a milestone, we have a millstone.

Finally, Mr. Berger's letter on "Management Analysis" (M/R, April 27, p. 7) coupled with "The Bovine Approach" letter (M/R, April 27, p. 7) of Messrs. Dickinson and Holden were most apt and timely. They should have been printed on the same page as the "steam" article.

(Name Withheld on Request)
Cocoa Beach, Fla.

P.S. By the way, I have your editorials "A Stag at Bay" and "The 150-Million-Dollar Failure" framed on the wall of my office.

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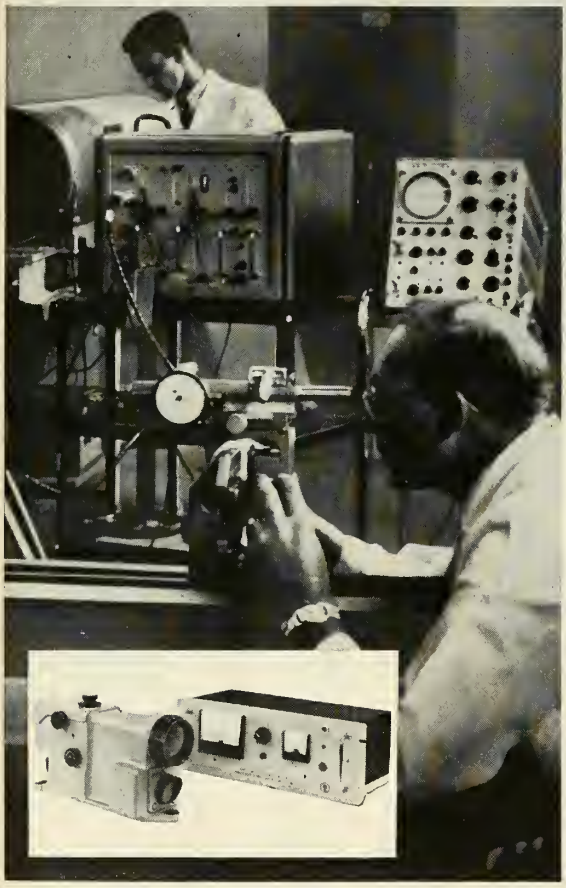
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The Countdown

WASHINGTON

Gemini Parasail Test Gratifying

NASA officials are hailing the recent test of the parasail system which when released at 11,000-ft. altitude landed a *Gemini* boilerplate at a speed of only 22.5 fps. This compares with a Project *Mercury* parachute system that landed that spacecraft at a speed of more than 30 fps. During the *Gemini* test, the steerable parasail put the craft within 150 ft. of the recovery boat. NASA officials are now predicting that it may be ready for use in the seventh *Gemini* flight.

Six Phoenixes for Navy TFX

In its announcement of the F-111A and B aircraft, the Air Force revealed that the Navy version would carry six *Phœnix* air-to-air missiles. They would be mounted on hard points on the non-movable portion of the TFX wing.

NASA May Profit from Point of Order

The Senate Space Committee report which is to detail funds authorized for NASA continues to lie in limbo while members are involved in other business, including presidential campaigning. Meanwhile, the House action in throwing out the appropriations bill on a point of order (M/R, May 25, p. 17) is expected to work in NASA's favor. This in effect will give the Senate—traditionally more generous than the House—the determining voice in the final amount.

Polaris Invulnerability Upgraded

Polaris submarines now have patrolled for a total of more than 5,000 days and during that time have encountered hundreds of visual or sonar contacts. However, the Navy boasts, there's no evidence that any of these contacts have ever detected a *Polaris* sub. This has led Navy planners to revise their estimates of the time when the vessels will have to be replaced. They're now looking toward the 1980's rather than the '70's.

Minuteman Missing in Kwajalein Report

The Army has disclosed for the first time the types of missiles being observed at Kwajalein in the *Nike-Zeus* series. They have included *Titan II*, both *D* and *E* versions of *Atlas*, and *Polaris*. Some of these vehicles, the Army says, have been accompanied by penetration aids. Notably missing from the Army announcement is mention of *Minuteman*.

Static Suspect in Delta Tragedy

Preliminary results of a space agency investigation indict "static discharge" as the probable cause of the April 14 premature ignition of the X-248 third stage of the *Delta* booster during spin tests at Cape Kennedy with the *Orbiting Solar Observatory*. Suspicion is that the raising and lowering of the polyethylene shroud around the *OSO* may have built up sufficient static electricity to trigger the solid-propellant stage's igniters and squibs. Other possibilities such as radio interference are being studied; a final decision is not expected for a few weeks.

Space Power Report Due Soon

A joint NASA/DOD group which has been studying the space power requirements of current and future U.S. space programs is nearing completion of its report. It's expected the group will brief the Joint Aeronautics and Astronautics Coordinating Board in mid-June.

Mariner Mars-Landing Capsule Is Out

Plans to land a capsule on Mars during the 1966 *Mariner* flights to that planet have been dropped. NASA's flight plans now call for a fly-by mission with a spacecraft weighing 800 to 900 lbs.

Upper-Stage PDP Contract at Hand

NASA expects to select a contractor in mid-June for the program definition phase of a 7,000-lb.-thrust high-energy upper stage. Competing for the award are seven firms—General Dynamics/Astronautics, Lockheed, Douglas, TRW Space Technology Laboratories, Space-General Corp., Boeing and Martin. Development funding may be included in the FY '66 budget.

INDUSTRY

'Poodle' Price Tag Is $54 Million

A rocket stage that will put 2,300 lbs. into synchronous orbit if used with a *Titan II*, or 40,000 lbs. into circular Earth orbit if used with a *Saturn*, can be developed for $54 million, says TRW Space Technology Laboratories. Working under a $570,000 AEC contract for study of applications of radioisotopes in space, STL came up with the idea of a rocket in which gaseous hydrogen gains energy as it passes over Polonium-210. First paper designs of "Poodle" show a 3-in.-dia. stage 13½ in. long that produces 0.25 lb. of thrust at a specific impulse of 700-800 secs. Stage for *Titan II* would be of four scaled-up rockets in a 10-ft. diameter, topped by a tank of liquid hydrogen with a radioactive source to provide boil-off.

Navy Small Hybrids Plan Poses Problems

Naval Ordnance Test Station/China Lake is expected to offer bids to industry on a small hybrid propulsion system for advanced air-to-surface and air-to-air missiles. Industry observers believe there will be more than usual difficulties, since one of the peculiarities of hybrid systems is that the smaller the motor, the greater the difficulties in getting efficient burning. They don't see any Navy interest in shipboard hybrid systems because of the envelope restrictions involved.

How to Learn to Love the Bomb

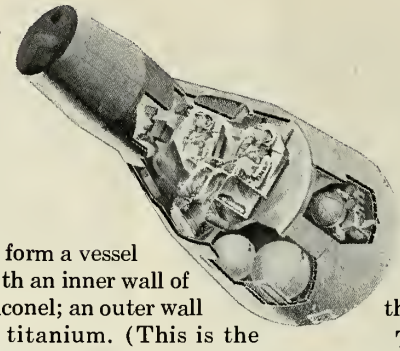
Despite technical, treaty, and public relations roadblocks delaying the use of controlled nuclear explosions in construction projects, the AEC has released, for planning purposes, figures on costs involved. It says a 10-kiloton device can be provided for $350,000, including arming and firing services. A 2-megaton device will cost $600,000. Bernard J. O'Keefe, executive vice president of Edgerton, Germeshausen & Grier, Inc., calculates that to construct a 46-mi.-long sea-level canal across Panama (political considerations aside) would require about 170 megatons of explosives and cost roughly a half-billion dollars—compared with $5 billion using conventional explosives.

INTERNATIONAL

First MLF Ship To Get Stiff Training

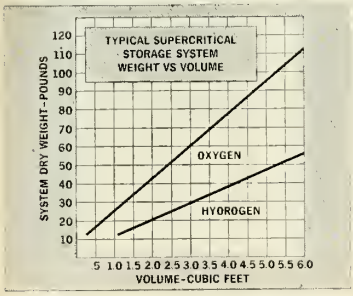
The USS Biddle, the guided missile destroyer being manned with a seven-nation crew, will be deployed after a six-month training period with both the Second and Sixth fleets. The Biddle is a test ship to prove the Multilateral Force (MLF) concept.

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UTC Reports Hybrids Progress

Hybrid rockets developing up to 75,000 lbs. of thrust are scheduled for firing in January by the United Technology Center, according to Douglas D. Ordahl, assistant manager for advanced technology.

Ordahl pointed out to the annual convention of the Aviation/Space Writers Association in Miami Beach last week that UTC has already successfully demonstrated the 6,000-lb.-thrust hybrid motor and is now working in the 12,000-lb.-thrust range.

Company Scientists predict that because of the advantages of hybrid rockets—including complete throttleability and controlled start-stop operation—the method will provide power for a wide variety of space missions before the end of the decade.

Ultimately hybrids promise to combine the most desirable performance characteristics of both liquid and solid rockets—with important advantages over both. Leading advantages include: the possibility of achieving any desired thrust cycle or thrust-time pattern—permitting constant thrust, modulated progressive thrust, stepped or programmed thrust, pulsed thrust or a modulated pulse.

Shots of the Week

The Navy scored successes in its initial two firings of the combat model *Polaris A-3* ICBM on May 25. Both launches were conducted from the atomic submarine, USS Daniel Webster, submerged off the coast of Florida. The missiles carried dummy warheads 1,500 mi. into an Atlantic Missile Range target area.

- NASA test pilot Milton Thompson was forced to make an emergency landing May 21 when the *X-15* rocket plane lost power half way through a test to gather information applicable to supersonic transport flight.
- The Air Force on May 25 launched a *Minuteman* ICBM from Vandenberg AFB, Calif., the 46th from that West Coast base. Firing was termed "routine" and was conducted by the 741st Strategic Missile Squadron of Minot AFB, N.D.

Firm Claims Comsat Success

A top Philco Corp. official has told Congress that his company would be ready to launch a medium-altitude communications satellite package in 12 months, given adequate funding.

Oscar T. Simpson, vice president and general manager of the Western Development Laboratories division of Philco, told the Military Operations subcommittee that the company "has eliminated every potentially weak reliability link" in the system.

He outlined these improvements: Elimination of the requirement for restarting the *Agena* engine during satellite ejection; elimination of the hot-gas secondary propulsion system, which would have worked at high temperatures requiring special membranes to separate propellants; development of specially screened components to avoid failures such as those experienced by *Telstar* and *Relay;* development of special vibration damping devices for lightweight structures, which eliminates the need for a heavy dispensing system to accommodate vibration during the launch phase.

The Philco official also said that the company is continuing to improve the anti-jam feature, studying radiation effects, improving the reliability of the traveling wave tube amplifier, resolving problems caused by the effects of the Earth's magnetic field on the spin axes, and integrating electrical systems to eliminate possible interactions.

Weather Satellite Proposed

Sylvania Electric Products, Inc., has recommended to NASA that a single satellite in polar orbit could provide a good system to collect weather and oceanographic information.

The firm recommended use of a single satellite in polar orbit at an altitude of between 500 and 700 n. mi. to collect information daily from about 1,200 sensors.

A $97,000 contract was awarded to Sylvania last year by NASA to study the use of satellites to collect data from remote parts of the Earth to expand existing knowledge of the sea and atmosphere.

Data would be transmitted from each sensor upon interrogation by the satellite. Each platform and balloon would be assigned a unique address and would be specifically interrogated when within line-of-sight of the satellite at maximum slant ranges of between 1,200 and 2,000 n.mi.

In the course of its orbit, the satellite would store the information it received from each sensor on a continuous loop magnetic tape. Upon command from a ground retrieval station, probably at Fairbanks, Alaska, the satellite would relay the data to computers for processing and distribution to meteorologists, oceanographers and other interested groups.

Compressor Forces SA-6 Slip

A frozen compressor in the ground support equipment caused a postponement in the launch of the *Saturn SA-6,* scheduled for May 26 at Cape Kennedy.

At the middle of last week, the launch had been re-scheduled for 9:00 a.m., May 28.

Technicians discovered a freeze-up of a large nitrogen gas compressor, designed to keep the on-board instrument unit cool, about 90 minutes before the scheduled lift-off. A decision to replace the whole unit resulted in a two-day delay to test the new component.

NEC Meeting Resistance

Continued resistance to the proposed National Economic Conversion commission is being voiced by various Administration spokesmen.

In spite of the enthusiastic support by influential members in the House and Senate, the executive branch's coolness to the idea makes it appear unlikely that the bill will be signed if passed.

As proposed by Sen. George McGovern (D-S.D.), the commission would be headed by the Secretary of Commerce. Other members would include the Secretaries of Defense, Labor, Interior, Agriculture, the chairmen of the Atomic Energy Commission and Council of Economic Advisors, the director of the National Aeronautics and Space Administration, and head of the Arms Control and Disarmament Agency.

Companies doing 25% of their business in government defense work would also be required to set up committees to study means of converting to other products should this business be lost.

The Atomic Energy Commission has argued that contract costs would increase if these companies had to support conversion planning departments. DOD's position has generally been that the situation needs no additional attention.

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* The Space Guidance Center was built on a 700-acre site in 1957 to contain IBM's defense and space efforts. Current projects include: TITAN II and III, SATURN I and V, GEMINI and MOL.

AEC Discounts Health Hazard

The 2.2 lbs. of plutonium 238 dumped into space during a satellite failure last month does not present a health hazard to the world, according to the Atomic Energy Commission.

AEC scientists have concluded that the material, the fuel supply for the SNAP-9A nuclear generator aboard the satellite, has been dispersed into fine particles suspended about 12,000 ft. above the west coast of Africa and will gradually lose its radioactivity.

The plutonium was deposited in space when a Navy navigation satellite launched from Vandenberg AFB, Calif., failed to obtain orbit. The satellite is believed to have been a *Transit* or *TRAAC*-type launched by a *Thor-Able-Star*. Failure was due to human error.

House Votes Defense Funds

The House has voted $1.599 billion for military construction appropriations, a reduction of almost $280 million from the Department of Defense request.

Missile/space funds in the bill include $4.7 million for protective construction for various *Nike-Hercules* sites, $25.5 million for research and development facilities in support of *Nike X* anti-missile missile program, $2.389 million for the Redstone Arsenal missile systems calibration facility, $8.1 million for test and evaluation facilities at Aberdeen Proving Ground, Md., Fort Huachuca, Ariz., and White Sands Missile Range.

The Navy received $645,000 for advanced underwater weapons facilities at the Naval Air Station, Moffett Field, Calif., and $8.5 million for research, development, test and evaluation stations. This RDT&E fund was reduced by $7 million from the request.

The Air Force was awarded $3 million for completion of the NORAD combat operations center, Colorado, $5.5 million for a toxic altitude propulsion research facility at Edwards AFB, Calif., and $1.4 million for the Atlantic Missile Range.

DOD Procedures Assailed

Executives of two major electronics firms have criticized new Dept. of Defense contract cost and control procedures.

Addressing the Third Annual Management Conference on Marketing in the Defense Industries last week in Boston (see also p. 21), Sylvania vice president Lawrence J. Straw said the procedures "have made the cost of scrutinizing the dollars . . . as much as the cost of doing the work."

Raytheon vice president for corporate development Lawrence Levy complained, "these rigid contractural procedures for R&D contracts have tended to stifle new ideas from industry and have caused reduced industry initiative."

However, Levy said he was encouraged "and surprised" recently to discover a memorandum issued April 18 to the three service secretaries signed by DDR&E Deputy Dr. Eugene Fubini and Thomas Morris, Assistant Secretary of Defense for Installations and Logistics.

The memo states, in part, "We are concerned that some of the procedures used in the procurement of R&D have become so rigid that they are inhibiting the use of the full capabilities of industry and substantially increasing costs to the government. . . . Under the proper circumstances, when it is necessary to compress the time period or to take advantage of a known industrial capability, or it is necessary to insure that a new product or idea is given financial support, it is desirable to negotiate directly and to contract without undue formality."

ComSat Stock Set for Sale

Communications Satellite Corp.'s initial issue of 5 million public shares is scheduled to go on sale June 2 at brokerage houses throughout the country.

Cost per share will be $20 and individuals will be limited to 50 shares.

How many of the 5-million shares originally reserved for common carrier buyers were actually bought prior to last week's deadline was not immediately revealed by ComSat.

Cutbacks Cost Jobs

Three aerospace firms announced moves last week that will cost the jobs of some 1,700 employees.

General Electric Co. announced plans to close its Advanced Electronics Center in Ithaca, N.Y. The firm expects to retain only 50-100 of the Center's 430 employees.

North American Aviation's Information Systems Div., Downey, Calif., will soon reduce *Apollo* program personnel by some 1,000.

Sylvania Electric Products, Inc., last week laid off 400 workers at its Santa Cruz, Calif., plant because of program cutbacks there.

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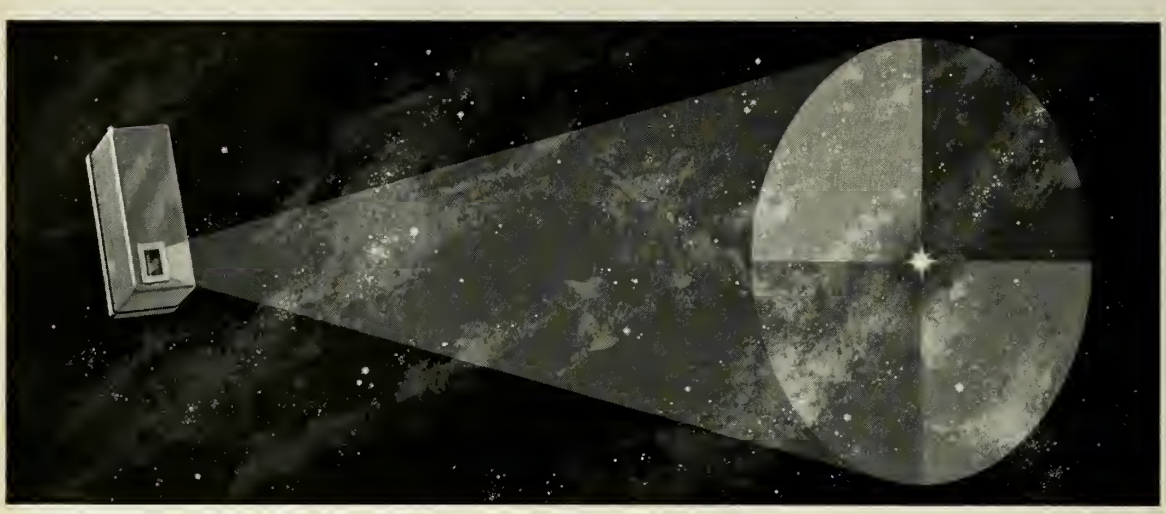
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Circle No. 10 on Subscriber Service Card

NEW HONEYWELL STAR TRACKERS

Simplified design brings higher reliability in new series



HONEYWELL'S GEOMETRIC LOGIC STAR TRACKER provides electronic tracking capability for space navigation and control systems.

Three highly advanced optical logic designs have been developed by Honeywell for its new series of simplified, accurate star trackers. These optical system designs—Geometric Logic, Mask Logic, and Digital Logic—replace complex electronic and mechanical scan/track systems. As a result, Honeywell star trackers provide new highs in reliability for space and daylight star tracking and for spin-stabilized vehicle reference systems.

Geometric Logic Star Tracker

Four-sector electronic switching provides simplified yet accurate and linear two-axis readout over a wide field of view, eliminating the need for complex raster scan electronics. The Geometric Logic Star Tracker has a reliability of 0.99 for a two-month mission and an MTBF approaching 200,000 hours with critical component redundancy. Designed for the visual spectral range between 3600 and 6000Å, the star tracker has a Quadrant Multiplier Phototube (QMP) which operates in three modes: acquisition, track and occult. The tracker detects the amplitude signals of all stars in its field of view of visual magnitude +3 and brighter. Through position information and amplitude of the star signal, the desired star is easily identified and the tracker locks on throughout the life of the mission. A simplified two-sector tracker is also being developed for single-axis requirements.

Mask Logic Star Tracker

The Honeywell Passively Scanned Star Telescope (PSST) is used to determine the spin rate and attitude in space of small, spin-stabilized vertical probes. Using no moving parts, the PSST detects stars of visual magnitude +3 and brighter with a signal-to-noise ratio of at least 16. The system transmits the signals to earth for comparison with known star information to determine the orientation of the vehicle. The PSST is designed for a maximum response between 3200 and 6000Å, and has a reliability of 0.99 for the mission.

Digital Logic Star Tracker

A precision daylight star tracker for stellar inertial and celestial navigation, the Pulse Code Modulation Star Tracker is a self-contained unit that offers a stable linear focal plane readout and a high signal-to-noise level in relation to error rate. Having only one moving part, the system's accuracy depends only upon the fixed optical characteristics of the tracker. The only signal processing required is the amplification of the detector output.

Honeywell Star Simulator

Independent adjustment of a desired star magnitude and star spectral content is offered by this simulator now under development. It can simulate star magnitude from −1.5 to +3.0 in 0.01 steps while providing independent star spectral adjustment for each of the seven basic star classifications with calibration accuracy of 1.5%.

FOR FURTHER INFORMATION on these star trackers and other Honeywell electro-optical systems, such as terminal guidance trackers, reconnaissance and surveillance systems, laser subsystems, radiometers, celestial trackers and scanners, and infrared detectors, write Honeywell Aeronautical Division, 1400 Soldiers Field Road, Boston, Mass., 02135.

Honeywell

Circle No. 11 on Subscriber Service Card

NASA Plans New Spacecraft

Prospects for FY '66 funding termed good for unmanned Mars exploration vehicles; projects are part of expanded planetary study

by Hal Taylor

THE SPACE AGENCY is moving toward development of two new spacecraft for unmanned exploration of Mars in 1969 and 1971.

And contrary to previous practices in the planetary program area, both will be developed and built for NASA by missile/space industry firms.

Two 1969 flights would be made with a heavy *Mariner*-type spacecraft with an estimated cost of $150 million. The 1971 mission will mark the first flight of the *Voyager* spacecraft—which will be the largest unmanned spacecraft project undertaken by NASA with a total pricetag of hundreds of millions of dollars.

Donald P. Hearth, director of advanced lunar and planetary programs in the Office of Space Sciences and Applications, told MISSILES AND ROCKETS that he expects both new projects to be funded in the FY '66 budget.

Hearth said that although neither has won program approval from top NASA officials, the chances for both appear to be good.

The two new spacecraft are only part of the planned expanded exploration of the Earth's nearest planetary neighbor. Efforts are expected to continue to increase as the U.S. moves toward manned circumlunar and landing missions on that planet in the 1980's.

Study of the planet will begin late this year when two 500-lb. *Mariner* spacecraft will be launched on Mars fly-by missions.

The fly-by mission could be repeated in 1966, but with a heavier spacecraft, weighing 800 to 900 lbs. The added weight will be made possible by the increased capability of the *Atlas-Centaur* booster. It will be used mainly to provide more spacecraft redundancy and more sophisticated experiments.

Although the 1966 missions are now on the drawing board, it is possible that they may be scrapped by top management if the 1964 flights are successful. Similar action followed *Mariner II's* successful fly-by of Venus in 1962 when a planned 1964 mission to the same planet was cancelled.

Hearth, however, believes that because of intense and increasing interest of the world scientific community in Mars exploration, this nation should not miss any opportunity to launch spacecraft to that planet.

● **Time is right**—He said that both 1969 and 1971 offer attractive launch windows, primarily because propulsion requirements to complete the mission would be the smallest of any period in the next 15 years.

Voyager had originally been planned as the vehicle for the 1969 mission. This, however, was contingent on FY '65 funding. When it became apparent that no money would be authorized in that fiscal year, space agency officials turned their attention to a spacecraft that could be launched with the *Atlas-Centaur* or the same launch vehicle uprated through the use of fluorine/oxygen (FLOX).

The in-house consideration of the mission began late in 1963 and is now being augmented by two study contracts with industry. Two mission concepts are being looked at—landing a survivable capsule on the Martian surface or what Hearth calls a "real good" orbital mission of perhaps three-months' duration.

Lockheed Aircraft Corp. on May 1 was awarded a contract to study the capsule lander mission and another missile/space firm is expected to be selected in the next two weeks to study the orbiter mission.

The four-month contracts provide for conceptual design studies. The *Mariner*-type spacecraft will weigh from 1,400 to 1,900 lbs., depending on the launch vehicle used. Based on the same consideration, if the capsule lander mission is selected, the capsule will weigh from 500 to 1,000 lbs.

The program will be funded in part with FY '65 funds, but the first heavy expenditure will be made in FY '66.

● **Industry will develop**—While no decision has been made, Hearth said, it is likely that for the first time in NASA's planetary program, industrial competition will be held to develop the spacecraft. Previously Cal Tech's Jet Propulsion Laboratory has developed all the *Mariner* spacecraft. The move to industry, he said, is probably because of the heavy workload at JPL.

Hearth said that plans now call for definitization of the project by the end of the year, with a request for proposals from industry for hardware development early in 1965. This would permit a "reasonable" 3½-year development schedule.

Turning to the *Voyager* spacecraft, the NASA official said that the chances of its going to Congress for approval in the NASA FY '66 authorization bill are good.

Total weight of the spacecraft will be about 7,000 lbs. Early flights are expected to combine both lander and orbiting capsules. Approximate weight for the orbiter is 1,500 to 2,000 lbs., and the space agency hopes to land a capsule of 1,500 to 3,000 lbs. on the surface.

It is hoped that data from both can be sent back to Earth for a period of six months.

Early planning schedules call for a preliminary design competition shortly after mid-1965. Then perhaps two contractors will be selected for this Phase I effort, which will be based on an incentive contract.

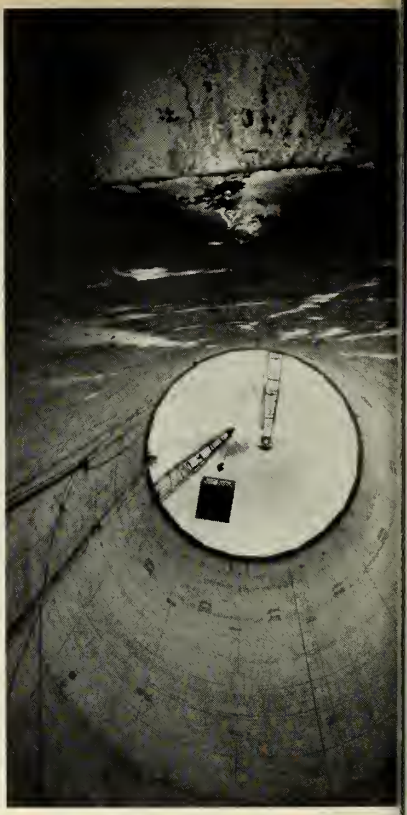
The contract will be valuable not only to the prime, but a large number of subcontractors are expected to be required.

A decision on the launch vehicle for *Voyager* is expected to be made by the end of this year. The two major contenders are the three-stage *Saturn IB* and the Air Force's *Titan III*. The NASA-developed *Saturn*-class booster is well in the lead at this point.

Looking into the future, Hearth predicted that *Voyager* will evolve into a strictly Mars lander spacecraft. ■







TOP: A movable, two-story building fits over this 177-ft.-deep cast-cure-firing pit. The half-length 260-in.-dia. solid will be loaded and cured in this pit. Nozzle will be attached and unit fired in the same location. BOTTOM: Air view of Aerojet-Dade division shows sprawling reinforced-concrete structures housing inert preparations, oxidizer preparation and propellant processing equipment. The Everglades are in the background. RIGHT: Looking up from the bottom of the huge cast-cure-firing pit. Special steel rigging will be used to support subscale 120-in.-dia. and half-length 260-in.-dia. test rockets.

Aerojet Dedicates Big Booster Plant

HOMESTEAD, FLA.—"Subscale One," a 120-in. segmented solid rocket, will be fired at the new Aerojet-General Corp. large solid processing plant sometime during August, 1964.

The firing will be part of the firm's participation in the USAF-NASA Large Solid Rocket Demonstration Program. The new plant, formally christened the Aerojet-Dade division by Dr. Edward C. Welsh, Executive Secretary of National Aeronautics and Space Council, will process the giant half-length 260-in. solid test unit.

The $23-million facility was dedicated May 26 in ceremonies attended by top executives from Aerojet-General, General Tire, Air Force, NASA and the contractors participating in the demonstration program. Also participating was Florida Gov. Farris Bryant and Rep. George P. Miller (D-Calif.), chairman of the House Space Committee.

Welsh sidestepped the unspoken question of the day with the phrase "I have no special message for you regarding the use of this new facility," in his keynote address. The Space Council Secretary then blasted Sen. Hugh Scott (R-Pa.) for his recent description of the U.S. lunar effort as a "mad man's race to the Moon."

Without referring to Scott by name, Welsh also denied the senator's claim that the *Apollo* program was on a crash basis. Welsh wondered "who the 'madman' is who is doing all this racing to the moon." "That is about the last label one would give to the serious-minded and expertly trained scientists, engineers, astronauts and executives who are involved in our space program," said Welsh.

Citing the Russians' early lead in liquid rockets, Welsh equated leadership in propulsions with leadership in space and warned against slowing the pace of U.S. progress in space.

● **South Dade Solids**—The Aerojet facility represents a 15% increase in U.S. solid-propellant producing capacity and the plant will be pouring propellant into "Subscale One" early this week.

Both batch and continuous mixing equipment has been installed and both approaches will be used in the large solid program. Aerojet designed the plant for flexibility and provisions have been made to easily accommodate barge-shipments of massive boosters to Cape Kennedy.

The plant features a huge concrete-lined cast-cure-firing pit capable of handling boosters 160 ft. long with thrusts in the 6 to 7-million-lb. range. (For a detailed first report on the Aerojet facility, readers are referred to MISSILES AND ROCKETS, Dec. 2, 1963, p. 29 and May 25, 1964, p. 26.) ■

Schriever Sees Materials Revolution

AFSC boss predicts 'greatest advance in 3,000 years' benefiting military and civilians; Polaris status report; new Sprint plans

by James Trainor

BAL HARBOUR, FLA.—A revolution in materials for aircraft, spacecraft and the whole civilian economy has been predicted by Gen. Bernard A. Schriever, chief of Air Force Systems Command.

"We are on the threshold of the greatest single (materials) advance that has been made in the last 3,000 years," Schriever asserted in a major address to the Aviation/Space Writers Association conference.

Specifically, the general told MISSILES AND ROCKETS that boron additives to filaments and fibers "associated with plastics" would give these materials great structural strength. The high strength-to-weight ratio of such materials would make them valuable in a wide spectrum of applications to both aerospace vehicles and commercial products.

Although several aerospace companies admitted they were involved in the development of these "acrylic fibers," they were reluctant to discuss the program because of the classification involved. One company estimated, however, that practical application of this new material is 10 to 15 years in the future—depending primarily on the amount of government support received.

Schriever foresaw similar advances in propulsion, guidance and computers "in the next 10 to 15 years."

● **Polaris program**—In 40 pre-deployment firings of the *Polaris A-2* missile from submarines, the missile landed in the designated target area 34 times, Rear Adm. I. J. Galantin told an AWA audience earlier in the week.

As part of a status report on the fleet ballistic missile program, the admiral dramatically revealed that the first two tactically configured *Polaris A-3's* had just been launched by the USS Daniel Webster, off-shore at the Atlantic Missile Range. Conducted 45 minutes apart, with the second coming just a couple of hours before the admiral's speech, the launches marked the beginning of a series of pre-deployment firings which, he said, "will become a matter of habit on the Atlantic Missile Range this summer. . . ." The *A-3* is scheduled to be operational in August of this year—two years after R&D firings began in 1962.

The Webster will be deployed later this year on the first operational patrol with *A-3* missiles. Presumably, it will be deployed to the Pacific, since Galantin noted that the missile would be deployed in this area "by the end of this year." Three *Polaris* submarines are already deployed in the Mediterranean. The Navy has 14 *Polaris* submarines deployed with 224 missiles aboard. The latest addition to this force was the USS Nathan Hale (SSBN 623), which Galantin announced had left on patrol from Charleston, S.C., on May 23.

Looking into the future, Galantin noted that the most immediate prospect for improvement of the *Polaris* deterrent system was the *B-3* program. Five million dollars in the FY '65 budget will allow the Navy to conduct project definition on the *B-3* missile. The more advanced version of the *Polaris* missile "would allow us either to have a greater payload or to attain more distance or to make trade-off combinations of these factors." In answer to a question, Galantin termed "a good guess" the statement that, for the same range as the *A-3*, the Navy could double the payload on the *B-3* over that boosted by the *A-3*.

● **Pop-up Sprint**—Army plans now call for using a separate ejector system for launching the high-acceleration *Sprint* missile from its underground cell, Col. I. O. Drewry, *Nike-X* project manager, revealed in a briefing to AWA members at Cape Kennedy.

Ignition of the missile would thereby take place in the atmosphere rather than the cell. Use of the separate ejector system rather than firing the *Sprint* from the cell offers two considerable advantages: a simpler, less expensive cell can be used and the missile can be ignited on-trajectory shortly after it leaves the cell.

A similar system is used in the *Polaris* and *MMRBM* programs. In the former, the ejection scheme is a steam-generated expulsion system; the method used in the *MMRBM* has not been revealed. Illustrating the simplicity of such an ejection scheme, Drewry pointed out that "right now we visualize the possibility of boring a hole with a big auger and slipping in a steel liner to make a launching cell." *Nike-Zeus*, in contrast, is fired through its protective covering.

The on-trajectory advantage, Drewry said, results from the fact that "at this point, its acceleration is still relatively low and a turn does not impose such a prohibitive g-loading on the missile airframe that it has to be beefed up structurally." With the time of flight of *Sprint* measured in "scant" seconds, the missile must make a bee-line to the target almost from the moment it clears the lip of the cell. The implication of Drewry's remarks, therefore, is that the missile will be ejected from the cell at low g and pointed at the target re-entry vehicle before ignition of the high-acceleration missile. Then, except for terminal maneuvers, the missile would be on its own.

Drewry's discussion touched on the Multi-function Array Radar (MAR), of which he said a test version would be turned on at White Sands "within 60 days"; the Missile Site Radar (MSR); the Hibex program; and the *Nike-X* data-processing computer, which he described as "several orders of magnitude faster and with greater capacity" than the *Nike-Zeus* 2,000-arithmetic-calculations-per-second capability (M/R, May 18, p. 14; May 25, p. 14).

First pictures of the *Squirt* missile firing at White Sands were shown to the AWA group, as well as a comparison firing of the *Zeus*. *Squirt*, although it "does not duplicate the *Sprint* in either design or flight characteristics," does provide the Army with a high-acceleration, off-the-shelf test vehicle for candidate *Sprint* materials as well as for gathering data on the aero-thermal effects encountered by "super-fast missiles operating in the Earth's atmosphere."

Squirt is made up of 14 solid-propellant motors—Recruits in the first stage and Cherokees in the second. Total vehicle length is 23 ft. ■

Langley Okays Multiple-Array Concept

Antenna system would combine sixteen 120-ft. units; hypersonic structures research are also detailed in week-long 'open house'

LANGLEY RESEARCH CENTER scientists have declared that a new Multiple Array Antenna System is completely feasible.

The system, which would combine sixteen 120-ft.-dia. antennas, would significantly reduce the amount of time required to receive transmissions from Mars.

The results of Langley's study of the system are especially meaningful because of the extended exploration of Mars which will take place in the next two decades.

The scientists reported on the study during a week-long open house at the center for industry and press representatives.

As an example of the advantages of the system, they said it could receive a picture transmission from Mars in 1½ hours. The same reception using a single 85-ft. antenna would currently take 2½ days.

The short reception time could be duplicated by a single 480-ft.-dia. antenna, but this would present perhaps insurmountable problems because of the power needed to move it around.

● **Hypersonic structures**—Officials at Langley also disclosed new details of their hypersonic aircraft structures research.

They said that a hypersonic vehicle going into Earth orbit and then re-entering would experience temperatures of 2,300°F on the nose cap, 2,500°F on the inlets and 1,600°F on the leading edges of the wings while traveling at Mach 7.

These temperatures, they pointed out, produce many structural problems.

One major problem is that the heat must be kept from vaporizing the fuel, particularly if it is liquid hydrogen.

Some insulation or a thermos-bottle effect must be produced between the structure and the fuel tank.

Langley research has come up with two possibilities. One is called a hot monocoque structure.

Between the hydrogen tank and the outer structure carbon dioxide is introduced. This gas prevents air from entering the unsealed structure. Should air get in around the tanks, it would liquify, freeze and add excessive weight to the vehicle. Some of the carbon dioxide gas condenses as a frost within the fibrous insulation on the tank. The lightweight frost is a good insulator and cools the fuel tank as it sublimes during flight.

The primary structure on the outside is made of a high-temperature superalloy in the form of a corrugation-stiffened panel structure. The CO_2 gas is between this structure and the tank. The tank is of aluminum waffle-plate construction. Panels of fibrous insulation are bonded to the outside surface of the tank. The CO_2 frost forms within the voids of this insulation adjacent to the tank wall.

A second structural concept for hypersonic aircraft is a multi-wall structure made of multiple layers of metal connected so as to produce an insulating effect. The multi-wall structure is a sandwich of dimpled and flat sheets that are joined together by welds at the crests of the dimples.

The polished outer layers form reflective shields that resist the transmission of heat. The spaces between these layers are evacuated. The inner layers form the primary load-carrying structure and also serve as the tank wall. ■





LEFT: Langley scientists in plexiglass space station airlock test model used to determine efficiency of crew transfer. ABOVE: Magnetic coil is used in Center wind tunnel to suspend spacecraft models without disturbances of physical contact.

DOD Official Hits Marketing 'Myths'

by Michael Getler

BOSTON—Summing up the proceedings at the Third Annual Management Conference on Marketing in the Defense Industries held at Boston College last week, Deputy Assistant Secretary of Defense for Arms Control Arthur Barber said there was now "a giant reluctance to face the facts" about the defense business and that marketing men must stop "writing myths" concerning new defense business. "Many of tbese so-called defense marketing plans of the future are really solutions looking for problems," he added.

Earlier in tbe program, Barber had stated flatly that the "defense business is going downhill. Everyone is worried," he added, "but no one is talking about it." And, he warned, unless new programs and markets are created in which the defense industry can compete, "this slight uneasiness is going to grow into an outright pain."

When questioned about the magnitude of future defense spending cutbacks, Barber cited as a workable estimate the 25% reduction by the end of the current 5-year period postulated by former Deputy Secretary of Defense Roswell L. Gilpatric in his now widely publicized article in tbe April issue of *Foreign Affairs*.

This same estimate was referred to in a speech to the same audience earlier in the day by Archibald S. Alexander, Assistant Director of the U. S. Arms Control and Disarmament Agency.

Among the examples of new business "myths" described in marketing memos passed on to corporate hierarchies within tbe past several months, Barber included such programs as the *Military Communications Satellite, MMRBM*, orbital bombing systems, and a multi-billion-dollar program on inspection hardware to accompany disarmament.

● **Building plowshares**—To offset what they feel will be a large decrease in defense spending, Barber and Alexander suggest the Defense industry consider turning it capabilities toward some of this country's "unmet needs." Barber has talked on this theme before (M/R, Dec. 23, 1963, p. 16).

"I believe," says Barber, "that all too few realize the type of society tbat it is possible to create in the United States in the next decade. It is possible to meet our needs in education, health, and other fields if we have the courage and willingness to tackle them."

Among the possibilities that Barber sees "already in tbe sales folders" of defense industries are low-cost automated medical systems, inexpensive mass surface and air transport networks, and water purification systems.

Barber called for creation of programs at all levels of government in which industry can participate and make a profit. Barber said "tbe defense industry can compete in the commercial sector if the government will help create the market." He said he expects to see RFP's begin flowing out of other than defense/space-oriented agencies within a year. He said that an important consideration in selecting areas in which the government will support new product development will be the applicability of that product to foreign sales.

Both Barber and Alexander said a mixture of Federal spending and tax reduction could combine to create the proper environment. Barber said that profit reforms are essential. "Profits and the public interest need not be a contradiction in terms. I am surprised," he said, "at many of my liberal friends who preach conversion of industrial concerns and then are shocked to think that someone might be interested in making a profit by developing better schools, better hospitals or water purification plants."

The magnitude of the cbange suggested by Barber and others is reflected in his defense of DOD:

"Apparently some people believe that the Defense Dept. and its contractors are responsible for limiting our national efforts on domestic problems. This is simply not true. The engineers, scientists and technicians now being released by some defense industries are not finding employment on projects to improve education, purify water, or improve transportation. There is no job exansion in these areas. The DOD and its budget is an excuse, not the cause, of our failure to vigorously tackle these domestic problems.

"This effort to make the DOD and its contractors scapegoats is based on the assumption that choices are made between missiles and schools, bombers and hospitals, urban transportation and outer space. The truth is, of course, that neither the Executive Department nor the Congress makes decisions this way; tbey evaluate each and every program separately and support those programs whicb they believe best serve the public interest. Paradoxically, the public bas shown relatively little interest in domestic problems."

● **A different view**—While most defense industry executives are aware of some rough sledding in the near-term spending picture, many remain very reluctant to get too far out of the defense business too fast. Many executives continue to harbor serious doubts about the ability of defense industries to compete in the commercial sector, the ability of the government at all levels to create profitable socially oriented programs, and the durability of the current East-West thaw. There is also a feeling, expressed here by speakers from Raytheon and Avco, and implied in a speech by Air Force Systems Command chief Gen. Bernard A. Schriever last week, that new concepts in defense and in weapons technology may be in the offing.

In the face of a conference program in whicb nearly all of the speakers represented government agencies (with beavy emphasis on arms control and disarmament), a somewhat different view for the industry was presented by Raytheon vice president Lawrence Levy, a former DOD representative to NATO.

Levy reported that the defense electronics situation, already in a squeeze, "may get worse over the next 18 months." He foresees some additional shake-outs for tbose firms that cannot absorb the loss in sales and fluctuations in employment. However, Levy adds, "we must recognize that in spite of budget cuts, cumbersome procedures, greater selectivity of procurement, and other factors, defense business continues to be the largest and most important market in the total U.S. economy. Defense work for those who have the capabilities and know-how can continue to be good and profitable business."

Levy, first noting the Administration's attitude that the presently planned strategic force will be "adequate" for our security, told the audience, "I must basten to add that I do not believe the Soviet Union has changed its long-range objective of world domination." ■

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Billion-Dollar Annual Market Is Due To Double by the End of the Decade

Beginning to receive a greater share of funding, the technology is entering a new area; a detailed examination by categories

THE U.S. ELECTRO-OPTICAL industrial/government systems market for Fiscal 1964 is expected to top $1 billion. Nearly half of this figure will be accounted for by the aerospace field.

By 1970, the annual market value is expected to double.

A new era is anticipated for spectrometry. Many new uses will be found for non-photographic instruments. They will be robust, all-electronic, high data rate, semiportable equipments.

Fiber optics is being employed less than was predicted earlier in some optimistic quarters. This is probably the result of the high degree of specialization required in each application. Technological problems, such as limited wavelength response, aperture and resolution, have had some effect also.

There is some tendency to de-emphasize infrared systems—except for thermal radiation. This has resulted partly from a growing appreciation of its proper role, and somewhat less from the difficulties of a technical nature, such as cooling requirements and the slow progress on practical imaging detectors, for anything but the near IR. Nevertheless, IR systems remain a major product area.

Some experts foresee greatly increased application of ultraviolet sensors because of the greatly increased activity in the space environment, where attenuation of short wavelengths does not occur. In this environment, the high sensitivity and the availability of image-forming sensors in the UV are great advantages. A need exists for good image converters in the region from Lyman alpha to ozone extinction.

Digital television applications are expected to greatly increase in the next few years. Once one pays the bandwidth penalty for going to the digital transmission of X-Y information, the additional benefits are very attractive. Some of them are the great convenience of PCM transmission, with its superior effectiveness and its compatibility with existing ground equipment; the practicability of on-board data handling in small vehicles; the evident advantages of compression, security coding, computer formating and analysis by machine.

New areas may be opened up for the use of TV in booster-engine monitoring. A miniaturized TV camera developed by General Electrodynamics Corp. has so far survived all the environmental extremes of vibration, g-loading and temperature necessary to qualify it for use under the *Saturn V* rocket. The tiny 10-lb. camera was developed by GEC for NASA's Marshall Space Flight Center and is expected to be flight-tested soon.

● **Laser emphasis broadens**—Paralleling the present research in optical maser technology is a growing trend toward applications research. A variety of lasers exist—crystal, gas and semiconductor—that have been operated in CW and pulsed modes at different powers and wavelengths.

Both industry and the government are now seeking practical systems. Emphasis has thus shifted to some degree toward developing those additional subsystems needed for working systems.

Government funding for Fiscal 1964 is estimated to be about $30 million. Industry, however, is believed to be investing at least another $20 million to strengthen its capability both in facilities and technical diversity.

The $20-million estimate may well be extremely conservative, for there is scarcely a missile/space prime contractor or electronics firm of over 100 people that has not managed to launch at least some effort in this field.

Early payoff for contenders is expected first in the areas of ranging and space communications, followed by high-resolution surveillance and reconnaissance systems. Farther down the road will trail systems for data processing, optical computers, space guidance and some form of weaponry. Laser welding and cutting tools already exist and will be steadily improved.

Laser market growth to an estimated $200 million in 1970 is probable, but only if laser systems are developed that can perform functions or operations better than other existing equipment. The "Gee whiz" days of punching holes in razor blades and issuing ear-catching pronouncements on such features as unlimited bandwidth and very narrow beamwidth may not be entirely over.

A Special M/R Report

THE COMPREHENSIVE survey of the electro-optical systems industry which begins on this page updates the state of the art and spotlights advanced research—the problems and the future requirements.

Compiled under the direction of M/R Senior Editor Charles D. LaFond, the report includes a market survey (this page) and separate articles on lasers (p. 26), range instrumentation (p. 33), guidance and navigation (p. 37), scientific or research instrumentation (p. 40), surveillance and reconnaissance (p. 44), metrology p. (49), and solar power conversion (p. 52).

but the time has come when the serious proponents will begin to produce hardware. It is to be hoped that some of the more vocal "laser toy" exponents will retire from the field or at least play more quietly.

● **Range changes**—Complexion of instrumentation requirements at the major U.S. ranges has been altered during the last several years. A steadily growing emphasis on the study of reentry physics phenomena and the ever-increasing need for better tracking accuracy and recording quality has generated a need for new and improved ground and airborne range electro-optical instrumentation. A second factor is time. Many of today's ranges are employing major systems that have been operational for from eight to 15 years —some even longer (El Centro is using 23-year-old Askanias).

Finally, a new market has opened up, at least temporarily, at European and Japanese ranges. France, Italy, Greece and Japan are now purchasing cinetheodolites, tracking telescopes and other small precision instruments to support their growing range operations.

Projects such as PRESS (Pacific Range Electromagnetic Signature Study), TRAP (Terminal Radiation Airborne Program) and RAMP (Radiation Airborne Measurement Program) have introduced a variety of new lightweight systems into the range field. Cameras, radiometers, IR trackers and spectrometers, television and other optical systems have proved their worth at high altitudes. These types of instruments are now being used for more conventional range applications.

The Astrionics Div. of Aerojet-General Corp.'s Von Karman Center has taken part in RAMP since early 1961 for the Air Force and ARPA. Using a modified C-135 over the Atlantic Missile Range, radiation signatures of ballistic missiles have been collected to identify their inherent characteristics.

The recent award of ALOTS (Airborne Lightweight Optics Tracking) system to Nortronics is the first major contract for development of AMR airborne range instrumentation.

USAF Cambridge Research Labs have employed such equipment for some time for ARPA studies and for scientific measurement purposes.

The replacement market for cinetheodolites, together with added systems for expanded range operations is expected to average 20 to 22 units per year through the next five to seven years.

J. W. Fecker Div. of American Optical Co. appears to have a tight hold in this field. In the past year, it has taken orders for the Contraves Cinetheodolite from Patrick AFB (seven), Eglin AFB (seven), the Navy's Autek Range (five) and Patuxent NAS (one).

Next year, Fiscal Year 1965, Sandia Corp. is expected to require from two to four; El Centro, four; Aberdeen Proving Grounds, three; and Yuma Test Station, two.

For the future, improvements are needed in cinetheodolite accuracy from the present five seconds of arc to one. More variable focal lengths, larger aperture (12 in.) with F.L. from 250 to 700 in. are needed. Frame size may be enlarged from 35 mm to 70 mm.

● **G&N growth unclear**—The largest part of today's electro-optical market in the field of guidance and navigation is in the infrared region, principally star trackers, IR terminal guidance and IR horizon sensors. Many observers see this also as the area of greatest expansion during the next five to ten years, but growth depends to a large extent on the types of future systems.

One major star-tracker manufacturer sees a potential for nearly 900 units during the FY '66-'72 period in the uncommitted market. The majority of these would be for an *Advanced Polaris* (775). The others for a variety of space programs, including reuseable boosters, *Voyager*, navigation and surveillance satellites and the several manned orbiting and maneuverable spacecraft now contemplated.

Stellar inertial guidance systems may also find future use in advanced versions of *Minuteman, Pershing* and, of course, *MMRBM*.

Another area of significance is in star-tracking periscopes for nuclear submarines. Kollmorgen controls this market almost totally. It has produced all the operational Type II-A periscopes to date and is now well along in the development of an advanced tracker for the new Type II-B periscope.

The highly specialized skills for producing such complex systems have been developed by Kollmorgen over a long time period and the result has been, for all practical purposes, a sole-source market by default.

A relatively new market area is that of fine-pointing control and stabilization for spacecraft. Kollsman Instrument Co. has performed well in this field and holds a sizeable portion of today's market.

Of probably greater growth potential, however, is the field of horizon-sensor systems. Nevertheless, the major effort today is in the development of improved sensors.

IR terminal guidance is a steady and growing market. Used in several *Falcons*, both *Sidewinder* models, *Redeye* and *Mauler*, it may also find use in *Phoenix*. It may be significant that the Air Force has ordered only the IR version of the Navy's new *Sidewinder IC* instead of the radar terminal guidance version.

● **Scientific instrumentation**—The field of special scientific instrumentation may well be as difficult to define as the efforts requiring such equipment. Best estimates of the current market place the figure somewhere between $70 and $80 million a year, with a growth rate paralleling dollar evaluation. In short, the market is steady and good, but little or no growth is predicted.

Purchasing scientific instruments, whether pure optical, electro-optical or photographic, is much like buying refrigerators. The items simply don't wear out. More advanced devices are produced, however, and these will continue to supplement or replace existing instruments.

Balloon-borne and spacecraft instrumentation will account for a large portion of the future funding in this field, although the number of units will be small. Project *Stratoscope* and the *Orbiting Astronomical Observatory* series, respectively, are the major flight programs today.

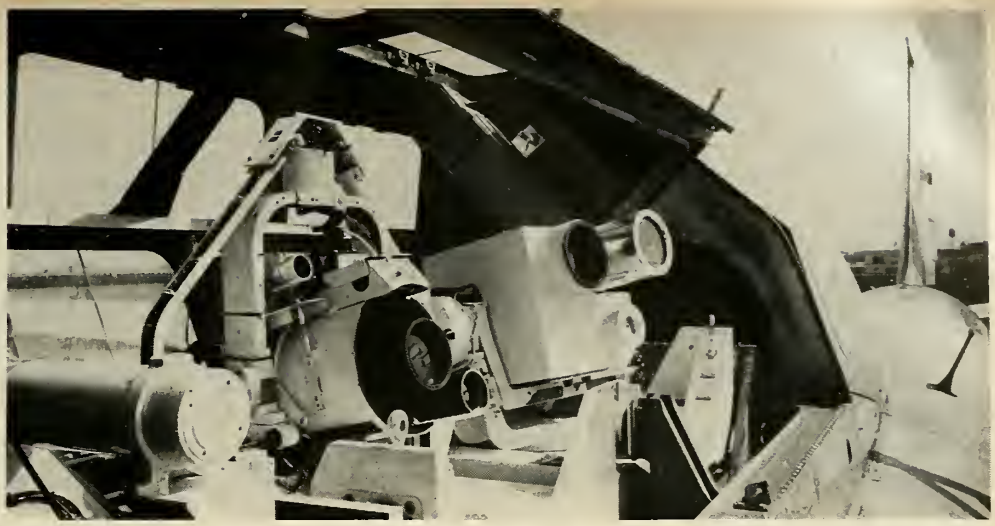
For the future, it has been proposed within NASA that an advanced *OAO* or *MORL* be employed which would be capable of carrying a 120-in.-dia. optical reflecting telescope. Early feasibility studies apparently have already been performed.

● **Surveillance and reconnaissance**—Dollar estimates in the field of sur-

SUMMARY OF INDUSTRY

ESTIMATES OF U.S. ELECTRO-OPTICAL SYSTEMS MARKET
(Includes RDT&E and Production, FY-1964-1970)

	'64	'66	'68	'70
		($ Millions)		
ELECTRO-OPTICAL SYSTEMS (excludes lasers)				
Industrial & Commercial	475	550	650	750
Scientific, Test Instrumentation and Process Control	125	150	175	200
Industrial and Special Photographic	350	400	475	550
GOVERNMENT	550	700	850	1,075
Aerospace	425	550	700	900
Other	125	150	150	175
LASERS (all applications, includes industry in-house R&D expenditures)	50	75	125	200
TOTAL	1,075	1,325	1,625	2,025



TYPIFYING increased use of airborne electro-optical instrumentation is this modified C-135 used for RAMP ballistic missile re-entry studies. Equipment includes an IR collimator (left), T-9 tracker (center) with boresight camera (upper left) atop P8 spectrometer and R1A radiometer, AN/PAR-4 raster scan and TV camera (right).

veillance and reconnaissance are too submerged in classified projects to be meaningful. The field is growing, however, and at a rapid rate. Present surveillance and reconnaissance optical systems are tending more and more toward large-diameter, fast and high-resolution instruments.

American Optical's Fecker Div., for example, has produced a number of extremely fast, wide-angle, high-resolution lenses. Typical of these are the solid Schmidt systems having an f ratio less than 0.4 and apertures larger than 14 in. These lenses have fields over 30 degrees and a resolving power of better than 33 lines per millimeter.

Another lens made by Fecker during the year is the Model 136 Hytar, which is also a wide-angle reconnaissance lens. This lens has been optimized for the response of moonlight on an S20 photocathode. The lens is completely protected by a watertight enclosure and is designed for high shock and vibration and a wide range of environmental temperatures. It has an f ratio of 0.8 and a focal length of 44 mm. Both the focus and the iris are controlled remotely in this system.

A transition and reduction is occurring in the application of conventional photographic techniques for reconnaissance purposes, both airborne and spaceborne. This transition is occasioned by the availability of a variety of satisfactory imaging detectors, by the difficulty of film processing, by the failure of halide photographic systems, regardless of speed, to provide real-time data, and by the growing appreciation of the dual roles of the photographic emulsion, namely, detection and storage. In halide photography, these functions were combined into one.

Purely photographic systems will still be used, but only in highly specialized or unusual circumstances. according to E. L. Crosby, electro-optical systems manager at Electro-Mechanical Research, Inc. The storage function may be performed by c-r devices (analog) and by magnetic drum or core array devices (digital), he asserted.

The detection function may be performed by any of several generic electro-optical devices typified, for the present, by the image orthicon. These devices have several very valuable performance superiorities when compared with halide film as a detector, including increased sensitivity, choice of integration time, wider wavelength response and physically static operation.

A change in design emphasis for image-forming optical subsystems is becoming evident. Formerly, regardless of the focal ratio required by the application, Earth-bound telescopes for purposes other than astronomy were limited in the design value of their apertures by the consequences of atmospheric turbulence. In space applications, however, since there is no turbulence, the instrument aperture may be given that value required by the required resolution. These will be of increased importance to sophisticated stabilization techniques in which the image is stabilized rather than any physical component of the instrument.

One of the significant coming developments in infrared, according to Dr. Finn J. Larsen of Honeywell, Inc., will be the availability of intrinsic 8-14 micron infrared detectors. Intrinsic detectors probably can be made for evaluation in less than a year, and these long-wavelength detectors probably will be available for operational use in two or three years. Extrinsic 8-14 micron detectors are now available, but require cooling to lower temperatures, he pointed out.

• **Metrology**—Optics and electro-optical systems are the heart of metrological instrumentation, due to their inherent accuracy. And nowhere is the need for such devices greater than in support of missiles and spacecraft fabrication and alignment.

Accuracies achieved with such instruments today have even surpassed the National Bureau of Standards ability for certification.

There is a move toward greater automaticity in metrological instrument operation and there also exists a growing tendency for a few of the major missile/space primes to build metrology labs and sell the service available therein.

Thus, there is a possibility in the field that while the requirements for precise measurement and alignment grow, instrument rates may level off due to the more efficient use of available instruments. The high cost of fine instruments will certainly not alter the trend.

• **Solar conversion devices**—While industry has pressed for nuclear-energy and fuel-cell electrical power generators, those in the field of solar energy conversion have continued to tighten their hold on the future market.

As the capability to produce more power more efficiently and reliably has improved, so has the general acceptance of such systems been fostered. As solar-cell panels have found more applications in the space field, the price has decreased.

On the horizon, however, is the solar thermionic converter. These long-life systems will offer relatively high power output. Efficiency will probably be low, but considering the source this loss is not necessarily important. ■

Laser Emphasis Shifting from Research Toward Application and Hardware

Speed of technological development gratifies experts; big payoff expected in surveillance and reconnaissance, weaponry, space communications, and data processing

WITHIN THE NEXT 12-24 months experimental laser systems will be tested in more than a score of proposed aerospace applications—the result of a gradual transition in laser development in which the forward motion has begun to shift from the research-oriented scientist to the applications-minded engineer.

While basic research continues to be vigorously pursued, there is now far more willingness among Government agencies to move ahead with hardware programs based on current technology in an attempt to see what actually can be done. Similarly, attention has turned away slightly from the primary search for new transitions at which materials will laser, and is now focused more on development of the vital components associated with laser applications such as improved receivers and detectors for specific frequencies, modulators, demodulators, amplifiers, beam-splitters, and new pumping and efficiency schemes that will yield higher peak and average powers and pulse repetition rates.

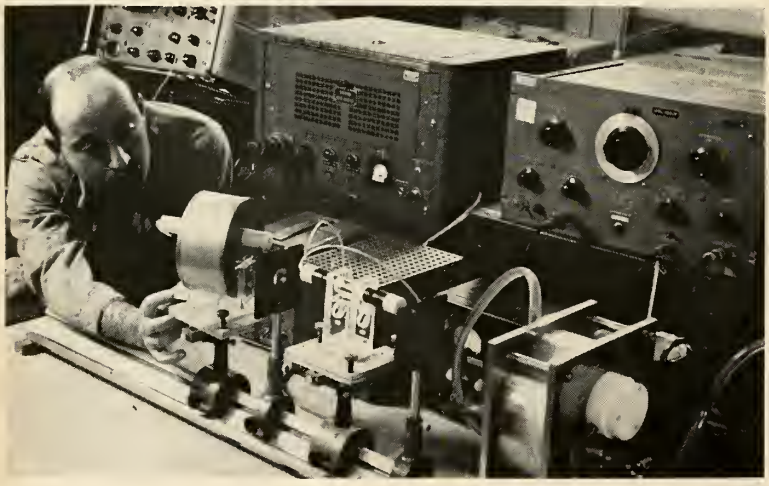
Laser technology, now barely four years old, has come along even faster than optimists 1-2 years ago predicted it would. For example, power and energy outputs in pulsed crystal-type lasers have been expanded greatly, causing a search for materials and optical systems that will not break down under the very high values. Gas lasers have now been made to operate over virtually the entire optical spectrum from the ultraviolet to the far infrared regions. Semiconductor-type lasers have exhibited 50% efficiencies and are increasing power levels and decreasing cooling requirements.

The laser is praised in all quarters as a new, exciting, and unquestionably useful "scientific research tool." Its use in very high-resolution optical spectroscopy, plasma probing, alignment, and other laboratory measurement roles is assured. However, that is about as far as the academicians will take it at this point. It now remains for the engineers to prove or disprove the value of this high-intensity coherent light source in the wide range of proposed uses.

There is little doubt that it will fail, in comparison to other available techniques, in some applications. However, there are believed to be areas where the laser is not merely a better way to do something; areas where, if it is successfully applied, it could fill vital voids defense and space capabilities. If there is to be a big pay-off for lasers, it will come in the areas of high-resolution surveillance and reconnaissance, weaponry, space communications, and data processing. The fact that the U.S. military and space agencies see this pay-off potential has inflated spending this year in laser technology to about $30 million.

STATE OF THE ART

Lasers are commonly classed by three major types: discharge-excited gas, electron-injection or semiconductor, and



THREE-LASER Sperry optical heterodyne radar operates at 1.06 microns. The transmitter's three lasers are mounted on the optical bench. On right, sandwiched between a pair of metal plates, is a neodymium-doped calcium tungstate CW laser oscillator. The preamplifier, a neodymium-doped calcium tungstate pulsed laser, is between the irises. The pulsed power amplifier, a neodymium-doped glass laser, is inside the squat cylinder being aligned by scientist. System's tiny receiver is behind his right shoulder. Three laser crystal boules are in foreground.

optically-pumped solid-state or crystal devices. There is also some work in liquid lasers, but these have lagged behind the other types. In any case, lasers have come to be identified by the active medium within the laser and the means of exciting it.

● **Gas Lasers**—Gas lasers now have been operated across an extremely wide portion of the optical spectrum. An announcement is expected this month from a Bell Telephone Laboratory team of a series of 14 new CW transitions, four of which are above 100 micron wavelengths and one of which reportedly is beyond 130 microns.

In the other direction, recent pulse and CW transitions reported by Hughes and BTL using pure argon or mixtures of argon with other gases have resulted in about 10 new transitions in the blue-green (4,545-5,287 Å) range, with what is termed "a highly promising low-threshold high-gain line at 4,880 Å." This line may be important to communications systems, according to some scientists who report peak photo-detector sensitivity is better in this region than in the red.

Even more recently, Hughes scientists last month reported both pulse and CW laser action at more than 60 new wavelengths ranging across the visible portion of the spectrum with a new gas ion laser in which both the singly and doubly-ionized states of four noble gas elements—argon, krypton, xenon, and neon—were used.

Gas lasers, until now relatively power-limited to about 1 watt CW, could be in for what one scientist calls "several orders of magnitude improvement" due to new work using excited states of various ionized noble gases. Maximum peak pulse power is now at about 200 watts for a 20-nanosec. pulse or 10 watts for 2 millisecs.

Though gas lasers are still power-limited and operate at the lowest input/output efficiency of any laser (optimistically about 0.1%), their high degree of monochromaticity and the excellent spatial and temporal coherence of the beam generated by the high optical quality of the gases makes this device the most widely used "scientific tool." Beam divergence on these lasers (about 10^{-4} radians) approaches the theoretical diffraction limit of light. Gas lasers can also operate without cooling at room temperatures.

Narrow linewidth properties of gas lasers will make them useful for metrology, and the ease of CW operation, for a possible role in Doppler radars and point-to-point communications (though modulation problems exist and very accurate pointing systems are required). Several firms are also attempting to take advantage of the narrow beams in space-to-space tracking and communications roles. Scientists at Lockheed have just developed a prototype tracking system with a 30-arc-sec. angular accuracy (M/R, May 18, p. 24). While the gas laser may also get an early ride in the atmosphere, perhaps as part of an airborne reconnaissance processing unit, its use in other than ground environments may eventually give way to semiconductor lasers. Gas lasers are highly sensitive to external vibrations.

Certainly the most important gas laser transition achieved to date, and the one most widely used, because of its beam and frequency stability, is the neon-helium laser, operating in the red at 6,328Å.

● **Semiconductor lasers**—These devices, sometimes known as injection or junction lasers, have been developed rapidly since they were first demonstrated late in 1962. Their use in space-based systems is particularly auspicious. Major interest continues to be focused on gallium arsenide lasers, which remain by far the most advanced technique, though many other semiconductor materials have been lasered.

The advantages of semiconductor lasers are numerous. Of prime importance is their extremely small size, their high efficiency (now approaching 50% at liquid nitrogen [77°K] temperatures), ease of modulation, and frequency tunability. The potential wavelengths for these devices range from about 0.4-5.0 microns. CW output at 20°K (liquid hydrogen) is now up to about 5 watts. About 200-300 watts peak power pulsed (10 nanosec) is also achievable, according to the scientists. The direct modulation of these devices reportedly extends into the 10-gc frequency region, providing considerable information capability, though with less coherency than with gas lasers.

Scientists at IBM believe that peak pulse powers in the kilowatt, and possibly even megawatt, range are possible and that this could put semiconductor lasers into some of the ground-space links now being discussed for other solid-state lasers. IBM is also making a major push, under NASA contract, to achieve room temperature operation with GaAs at high efficiencies. Room temperature quantum efficiency in the beam is now believed to be about 15%, but at low outputs.

Air Force scientists feel that the best bet for improvements in lowering injection currents, controlling junction temperatures, and room temperature-high efficiency operation "seems to lie in the exploration of new semiconductor materials with large band gap energies."

IBM is now building a GaAs device for a one-way voice communications link for the *Gemini* program. TV and voice transmissions have already been sent short distances with GaAs lasers. IBM scientists also claim recent success in development of new optical hetrodyne detection techniques, which they claim allowed reliable GaAs laser linewidth measurements to be resolved down to 1 mc, a 100:1 improvement over previously used resolution-limited spectrometer methods.

The elimination of some diode noise could lead to measurements down to 150 kc, the scientists claim, perhaps eventually getting down into the 10-kc area. If this could be accomplished, injection laser Doppler radars would become feasible, according to IBM, offering velocity measurements on the order of 0.01 fps, roughly an order-of-magnitude better than conventional radar techniques.

Tied in to the Doppler radar concept is a new IBM-developed GaAs small-signal amplifier, which reportedly has a 37-db gain, allowing coherent Doppler measurements at low power and with a narrow beam. The low-noise device can also be used, according to IBM, to replace photomultiplier tubes as detectors in optical systems.

Injection lasers may play a large role in optical computers, where the very fast 0.2-nanosec. pulses could be used for optical logic, removing the traditional electronics and avoiding inductance and capacitance problems. Engineers say a range of flip-flop circuits and gates could be made with these devices. Their application as light-pumping sources matched to the absorption bands of other laser materials is also viewed with interest.

● **Crystal lasers**—Though more than a dozen materials in this category have exhibited laser action, pulsed ruby and pulsed neodymium-doped glass lasers continue to get most attention. Both are capable of putting out great bursts of energy in short pulses, which makes them focal points for the long-range high-energy projects under consideration by the military.

With the addition of "Q-spoiling" (a technique in which the optically resonant cavity is not formed until the crystal has been pumped, and when it is formed all of the energy is dumped in a single pulse) devices, peak powers from pulsed ruby lasers on the order of 3,000-5,000 megawatts, delivered in pulses of about 10-nanosec. duration, are now possible under research conditions. Efficiencies for the Q-spoiled devices, however, are extremely low—on the order of 0.1%. Pulse repetition frequencies (PRF) of these huge bursts are also very low, believed to be on the order of a few minutes using air-cooled ruby crystals. This can probably be increased to a few pulses per minute, according to one expert, by additional engineering on the cooling system, which he points out is not critical at

this point. PRF's without cooling are higher, but performance degrades rapidly. Efficiencies of the non-Q-spoiled lasers are considerably higher, approaching about 4% for some solid-state devices.

In terms of joules, or actual laser pulse energy, the highest reported output is about 2,000 joules in roughly a 5-millisec. pulse using neodymium-doped glass, which, while more fragile than the ruby, is believed to be capable of higher pulse energies and have better optical qualities. The primary radiation from this laser is invisible. However, it also has a larger spectral and angular-beam spread. Some firms (including Maser Optics and Raytheon) have reported development efforts toward 4,000-5,000 joule output energies.

According to George R. White of Electro-Optical Systems, Inc., in Pasadena, Calif., for two specialized applications, neodymium-in-glass has major advantages over ruby. First, he points out, its second-harmonic wavelength of 5,300 Å is near the absortion minimum of sea water, and at the spectral sensitivity maximum of photocathodes and the human eye. Second, he adds, it has the same wavelength as neodymium-in-calcium-tungstate CW oscillators, allowing a CW oscillator pulsed amplifier combination with very high spectral purity at high power.

Recent developments in new Q-switching techniques include announcement by IBM in April of a new and relatively simple giant-pulse-producing cell filled with a phthalocyanine solution. The work has had some Army support. Beckman & Whitley in San Carlos, Calif., last month also announced development of a thin-film laser Q-switch consisting of an optical glass substrate supporting a thin film of passive absorbent material.

Several studies are under way in-house and with industry to test optical lens systems, coatings, and components under the heavy loads of high-power Q-switched lasers. For example, Perkin-Elmer scientists are working on this problem under Army funding using a 50-Mw ruby laser for the experiments. Answers in this area are vital to accomplishment of many projected laser roles where power demands are severe due to ranging of non-cooperative targets.

MILITARY PROGRAMS

● **High-power lasers**—The Dept. of Defense's high-power-laser program is a broad-based effort to develop higher powered, more efficient laser systems with the potential for major missile/space and aircraft defense applications.

In the past three months, DOD has formed an informal committee to oversee the entire military effort in high-power lasers. The committee, which has "general funding control over these programs," is headed by Chalmers W. Sherwin, Deputy Director (Research and Technology) within the Office of the Director, Defense Research and Engineering. The six-man committee, which held its first meeting in April, includes representatives from all three services and DDR&E's Advanced Research Projects Agency.

Sherwin says the high-power technology project "is a reasonable effort, not a gigantic program. The problems are very formidable for high-energy application, but we are neither wild-eyed nor pessimistic." Sherwin adds that "things have come along in this field about as fast as the solid experimenters have predicted."

DOD shows no inclination to tip its hand as to progress in the application of high-power systems to the weapons or surveillance programs. U.S. laser technology, it is believed, is considerably more advanced than Russian capabilities in this field.

● **A-ICBM systems**—Use of perhaps millions of megawatts or hundreds of joules in rapid, very high-energy pulses to destroy incoming warheads is still a very distant possibility for the pulsed ruby or neodymium-doped glass lasers; however, scientists are now probably a good bit closer to at least making a better evaluation of that potential than they were a year ago. Peak power and joule outputs now achievable within the DOD program are highly classified, but many observers speculate they are well above that which has been labeled state-of-the-art in the preceding discussion.

Both peak power in terms of megawatts per pulse duration and total energy in terms of joules are important in relation to the A-ICBM problem, since both the rate at which the energy arrives and the amount of energy can introduce separate but effective damage mechanisms on a target. The joules per sq. cm. is, however, probably more important.

For example, observers point out that it is not necessary to actually burn a hole in an incoming warhead to render it ineffective. By putting enough joules per sq. cm. on the target, the severe thermal energies introduced can probably cause enough of an imbalance at least to throw the vehicle off course.

While warhead re-design may appear to be an easy and inexpensive way to guard against laser A-ICBM weapons should they ever be developed, experts point out that there are difficult problems here also—e.g., knowledge of specific wavelengths at which the laser is operating, alteration of re-entry characteristics due to possible addition of protective or reflected coatings, and possibly severe heat dissipation problems.

Producing adequate power is not the only difficulty in developing a laser A-ICBM weapon. Pointing the narrow beam at the target and keeping it there is also a major concern—but one that is believed to have yielded to some progress in the past year. Several firms are developing combination IR-laser-tracker-rangers designed to acquire targets with already highly developed IR seekers, using them to keep the laser beam locked on. The extensive military effort to determine satellite tracking capabilities with new laser systems will feed the overall pointing problem, though the relative speeds involved are of course much different.

The DOD high-power program, whose members are quick to stress it is not called a high-power weapons program, will put major emphasis on the several technical areas that are limiting useful applications for these devices, namely a study of atmospheric attenuation (probably the single most complicating factor), laser and optical system materials breakdown under high-energy pulsing, and new pumping.

● **Long-range surveillance**—Many laser systems engineers believe that because the laser's tremendous output energy can be used to form an image of a target, and because its output is pulsed to add the range dimension, its use to determine target position and identification data simultaneously will place it more realistically as a satellite surveillance device or possibly in a role earlier in the A-ICBM problem than the intercept, such as in a warhead position-fixing or decoy-sorting mission.

For this portion of the high-power program, Q-switched devices are not what is needed, one expert told MISSILES AND ROCKETS, but straight pulsed devices that can be used for coherent detection. When using coherent detection with optical hetrodyning in a surveillance radar system, scientists are concerned mostly with the number of joules per pulse rather than with peak power, since basically there are fewer photons out per pulse with the highly Q-switched device. The more photons in a pulse the better is the signal-to-noise ratio. This, says one expert, is about the exact analog of microwave radar systems; here it is the average power that counts, not the peak. Non-Q-switched pulsed ruby reportedly will now put out in excess of 100 joules in pulses of a few microsecs. duration.

If laser surveillance systems can be developed to any serviceable extent, which some believe they can, they may prove to be of extreme value in areas other than mere profiling of unidentified non-cooperative satellites. One expert told M/R the laser could become a vital means for tracking maneuverable re-entry vehicles. Much work is going on within the military and NASA on using

the laser in re-entry physics and communications problems. Also, it may provide the ability to gain valuable mission and configuration data on non-U.S. launched probes traveling away from the Earth, which would normally be quickly out of the useful data range of more conventional systems.

The Air Force is now embarked on a major program to determine just how well spaceborne vehicles can be acquired and tracked with laser and electro-optical transmit/receive systems.

A major input to this program will come from the Air Force's laser-optical tracking complex being put into service in the vicinity of Cloudcroft, N.M.

Two separate projects are going on at Cloudcroft, set upon mountain peaks about a half-mile apart. However, they will support each other in certain respects. Both programs are highly important to the future use of laser ground-based surveillance and, according to Air Force officers, are "pushing the state of the art about as hard as it can be pushed."

On one peak, an Aeronautical Systems Div. laser research project has been set up, using a high-power laser transmitter in conjunction with a 48-in.-aperture telescope tracker and receiver, to bounce and measure high-intensity light off non-cooperative Air Force satellites. The laser beam is chopped to provide highly accurate range information, reported to be on the order of a fraction of an inch in range resolution. The installation began R&D operation this spring.

Nearby, on top of a 9,000-ft. peak, is the Air Force's Prototype Optical Surveillance System (M/R, Feb. 24, p. 44), now slated for acceptance testing in September. Initial subsystems tests are now going on. POSS, which is being set up by the Electronic Systems Div. as a potential member of the SPADATS network, is essentially a "detection optics" system, concerned with detecting new targets and cancelling star fields, rather than a "configuration optics" system such as the ASD project, which is concerned with the detailed parameters of the target. In this respect, the POSS facility, being developed by RCA with Perkin-Elmer Corp. supplying the optics, will feed new target data and look angles to the ASD project.

POSS also includes new optical advances. The system, which uses a modified 27-in. F/1 Baker-Schmidt telescope, includes a 30-in. folding flat beryllium mirror, a 45-in. fused quartz primary mirror, and a multimillion-fiber matrix of fiber optics believed to be the largest single use of this technique to date. The fiber optics bundles translate the received light about 20 in. to the input end of several image orthicon cameras (see p. 42).

● **Other radar projects**—Other important possibilities in the Air Force's search for optical radars include the development of a feasibility-breadboard model of a new optical heterodyne radar by Sperry Rand's Electro-Optics Group at Great Neck, N.Y. The firm was awarded a $196,340 contract this spring by the Rome Air Development Center. The Sperry design calls for a three-laser system, operating at 1.06 microns, in which a gas laser local oscillator operates in tandem with a pair of solid-state laser amplifiers. Pulsed output could range from 10 watts to 10 Kw. A new germanium diode detector will be used which reportedy has demonstrated 25-db. parametric gain, and is expected, according to Sperry, to demodulate optical signals as high as 25 gc carried to it on less than 10^{-9} watt.

Raytheon engineers this fall will present results of a 12-month study of laser rendezvous techniques and required components to ASD. Engineers from Philco are working on an Air Force project to establish techniques for steering the beam of a single laser with an eye towards forming electronically scanned optical phased arrays for wide-angle scanning and higher effective transmitter powers.

The Air Force, through both ASD and RADC, has also embarked on a major program to develop better components for advanced coherent optical radars. Sperry Rand Corp. earlier this year was awarded $84,000 from ASD for development of a new high-power CW electroluminescent light source, an IR device with about 10 watts output.

Electro-Optical Systems, Inc. has gathered a series of contracts from RADC since last fall calling for development of such items as an optical circuit component (an interferometric module) which could be applied in laser optical circuits where the original input beam must be split or attenuated to perform other system functions, or in surveillance systems for control of phase coherence. EOS is also building, under AF contracts, a matched laser oscillator amplifier combination and a low-level coherent beam amplifier for laser surveillance systems.

● **Laser scanning**—Under study at United Aircraft's Research Lab, under Navy Bureau of Weapons funding, and at the National Engineering and Science Co. in California, under RADC sponsorship, are laser scanning techniques. Perkin-Elmer Corp. also has RADC funds for scanning studies. Many of these are related to display purposes.

● **Laser display**—Laser display techniques are expected to have a major application to new command and control systems if they can be modulated and scanned easily enough to provide the real-time, dynamic high-resolution displays desired. RADC has been a focal point for this type of application funding. The center is concentrating on development of a two-scanner (vertical and horizontal) system and experimental results to date indicate several possible approaches to solving the problem. RADC has also funded Texas Instruments for a laser display model to be used as a research tool in evaluating the display concept.

● **Laser rotational sensors**—Major progress is reported in the field of laser rotational sensors (M/R, Feb. 18, 1963, p. 28) regarding increased sensitivity and decreased size. Sperry, General Precision, and Honeywell are all continuing with programs and are claiming operational-type systems within the next year or 18 months. Sperry says its ring laser's minimum detectable rotation is now at 3 degrees/hr., where it was 2 degrees/min. a year ago. They see no fundamental limits to bringing this down to 10^{-2} or 10^{-3} degrees/hr. Smallest Sperry unit built thus far has four 10-in. legs. They expect this to get down to 4 in. on a side. The Honeywell gyro is triangular, and they now claim the smallest device, with a total path length of 50 cm, or just under 20 in. While the laser gyro still has not been "accepted by the spinning wheel types," several engineers believe the device will be lower in cost and operationally competitive in the long run with some of the 0.1 degree/hr. conventional gyros having a sizable market.

Ring laser technology, according to Sperry, has also had considerable fall-out in the laser instrumentation area, especially for material flow rate measurements.

● **Underwater surveillance**—Recent laser transitions in the blue-green have lent further speculation to possible use of lasers as undersea detection and ranging devices. While several firms are known to be pursuing this idea—some with Navy support—scientists in general believe the attenuation and temperature problems in all but the clearest sea water would render the laser far less useful than conventional techniques.

One jocular scientist suggested that the best use might come in trying to find NASA's ill-fated *S-66* laser-tracking satellite which now rests somewhere on the bottom of the Atlantic Ocean.

● **CAT detection**—Several firms, including Honeywell, Sperry and Lear Siegler, are studying the potential of lasers as detectors of clear air turbulence. Sperry, for example, is particularly interested in the strong atmospheric back-scatter properties of the short-wavelength blue laser. Sperry also feels the device could make a good true air speed indicator, making Doppler type measurements of undisturbed air far out in front of the disturbed air surrounding an aircraft. LSI reports it has already made preliminary CAT studies using a Q-switched solid-state laser. Honeywell,

under Air Force Cambridge Research Laboratory funding, is making test-chamber CAT runs with pulsed lasers.

● **Anti-tank weapons**—Pulsed solid-state lasers are a natural for anti-tank range finders. However, as one scientist points out, it would be well to make an effort to develop detectors suitable for Q-switched neodymium rather than for the Q-switched ruby now used for this application mostly because of the detector availability. The neodymium radiation is invisible, while the ruby is in the red portion of the spectrum. "If you wink a bright red light at everybody you want to shoot, you are going to give him a good few seconds to get the heck out of the way."

● **Laser countermeasures**—Use of lasers in ground or spaceborne systems as a means to blind IR or other heat-sensitive sensors is also being studied by the military. And there is the possibility of aircraft-mounted anti-*Sidewinder* defensive-type systems. Use aboard satellites or space stations as surveillance or defensive weapons may become more feasible than it now appears, given improvements in higher-powered semiconductor lasers.

● **Launch-phase missile tracking**—Decision is expected this month on a proposed laser tracking system for AF missiles during launch phase at Cape Kennedy (M/R, May 4, p. 22).

● **Reconnaissance**—Lasers are being developed for a wide range of missions, including their use as a target illuminator, which has in many cases reopened the field of recon camera optical system design (M/R, March 30, p. 90). Laser space reconnaissance potential will probably be tested during the *MOL* program.

Utilization as a light source in optical signal processing is also held as significant, the laser serving as an optical analog computer where very high data rate at somewhat reduced accuracies are required, and as a rapid scanner-sorter with recognizable spectrum patterns in such areas as photographic reconnaissance. The use of optical computers, or correlators, is believed to be in the experimental stage with reconnaissance and communications systems; however, it is thought to be in service with airborne synthetic-aperture side-looking radar schemes. Substitution of a laser source (probably a small low-power CW gas device) for earlier methods has already taken place in the radar area. Use of lasers as light sources in a variety of these optical correlators could allow space communications at very low signal levels or provide secure anti-jam communications.

To assist Air Force research in large-capacity communications systems, Sylvania Electric Products, Inc., a subsidiary of General Telephone and Electronics Corp., has built a compact wideband laser modulator. Sylvania says it plans to reduce the size of the current 18-in. model to about 3-4 in., prior to delivery to the Air Force Avionics Lab at Wright-Patterson AFB. The modulator has a theoretical capacity, according to the firm, for handling simultaneously more than 100,000 telephone conversations or 100 TV broadcasts on a single channel.

NASA PROGRAMS

While a lot of energy is still being expended within NASA's Office of Advanced Research and Technology in efforts to find out just what types of laser systems are suitable for NASA's needs, the space agency is on the brink of launching two or three of the programs, which will have major impact on laser applications. These involve the second attempt this summer to launch the *S-66* laser-tracking satellite (M/R, Aug. 5, p. 21), the development of a laser space-to-ground voice link experiment to be tried during Project *Gemini*, and the possible development of an *Optical Technology Satellite*.

● **Communications**—NASA's primary interest in lasers at this time is as a means to increase the data capacity of its communications system.

A commercial laser communications system may be 15 years away, if it comes at all, because here is where it may meet its stiffest economic joust with microwaves. NASA, on the other hand, could be in the laser communication business rather heavily within perhaps three years.

Scientists say that for near-Earth satellites, the data needs can be handled with available equipment—though for some that handle increased data loads such as weather and communications vehicles, the data rates could swamp capacities.

For deep space missions, the need for laser communications becomes quickly apparent. About 8 bits/sec. was available on the Venus probe and only a fraction more is expected on the *Mariner* probe of Mars. With lasers on board, NASA scientists feel it is possible to transmit real-time black and white TV over Mars distances with only about 1 watt CW power (about 50 million bits/sec. is required for TV). About an 8,000 bit/sec. rate is achievable now with a small, 100-milliwatt CW gas laser, according to NASA, "if it could be controlled." Whereas the power and beamwidth can be achieved, NASA is pressing hard for development of techniques that will allow accurate beam pointing and coherent receiver detection over long distances and time intervals.



SPERRY LASER tracker uses infrared angle measurement to aim a ruby laser beam for range finding on aircraft targets.

Beamwidths, they point out, would be on the order of arc seconds and would have to be pointed to within tenths of an arc sec., the problem getting more severe with increased range since the beam must be made narrower to compensate for the range increase. "If you can get a receiver with that kind of accuracy, the question is then can it hold it, considering the fact that the feedback loop may be 45 minutes long."

To determine just what are the fundamental pointing limitations associated with space-based laser systems, OART, in an attempt to provide the best direction for its research in this area, has asked for industry proposals for a year's study of the limitations. About 15 firms have responded and contractor selection is expected this month.

Communications with near-Earth satellites, unless at synchronous altitudes, also impose inaccuracies caused

by motion and tracking problems.

NASA's *MIROS* project (M R, Nov. 25, p. 48) is, in effect, an attempt to put the control and stabilization problems in an environment where it can be controlled—on the ground. The idea here is to build a ground system with enough power and bandwidth to compensate for atmospheric refraction and slight spacecraft position uncertainties. *MIROS*, a passive satellite program involving data transfer by cross-coupling optical beams, is being worked on by Westinghouse and Philco. *MIROS* is also being looked at for over-the-lunar-horizon application.

As part of the *MIROS* program, Goddard Space Flight Center last month issued an RFP for a modulatable corner-reflector assembly, which could be test-flown aboard a satellite, possibly an *Advanced Syncom*. Proposals were due from industry last week. A decision is expected this month on a contractor to built a flyable prototype, delivered to NASA in about 18 months. The system would probably use a power amplifier on board to alter mirror system characteristics that would impose modulation.

Just where to put a receiver is also a major question confronting NASA. For coherent detection with hetrodyning techniques, scientists say a relatively small aperture system would have to be used, possibly in arrays that demand complex electronics. Coherent detection could probably be done much more easily from balloon- or aircraft-borne receivers, and there is a possibility that the space agency will conduct experiments in this vein. While the effort is directed to ground-based coherent detection, early systems will no doubt use straight-power detection receivers of relatively large 48- to 60-in. apertures, which will reduce sensitivity and information content.

Ground-based systems, as NASA sees them, have many advantages despite the weather and atmospheric attentuation problems. In many respects, the weather problem can be overcome, they feel, by development of small inexpensive ground stations, which no matter how numerously deployed would still probably be cheaper than building some of the more expensive large microwave dishes. Eight selected sites around the globe, they point out, would give 96% continuous coverage of a deep space probe, with a continuous overlap of three stations.

NASA says it is still looking for a good single-frequency laser as a space communications device, though it is not resolved on the optimum frequency. The *S-66* launch this summer, if successful, is expected to give NASA the data it needs to "start refining the numbers."

OART officials told M R they may come out with an RFP in July or August that would request industry definition of the kind of laser that may be best suited to the communications needs of the agency. No hardware will be built in the initial phase.

NASA officials say that they could not get a laser system launched until FY '66 in any event, primarily because they do not yet have a well-defined program. A procurement out of the Marshall Space Flight Center should help with the definition. MSFC has asked for industry proposals on the types of experiments that could go aboard an *Optical Technology Satellite* or, if not on a satellite, as experimental passengers aboard *Saturn* test shots. The first phase of the program will be a 6-month study to determine the desirability of a satellite for these purposes and the types of experiments it could carry. Proposals were due last week and selection will be made this month.

While NASA has a number of in-house and industry study and component development contracts in effect, the major hardware development at this time is IBM's GaAs laser 1,500-mile slant-range voice communications link, which will get its first ride during the *Gemini* program.

The key to the IBM design is the development of a forward-biased semiconductor diode transmitter, which will operate in the IR (0.9 micron) without cryogenic cooling. The system will use PFM modulation with a "potential" for PCM. It will have a 10-watt peak power, 100-milliwatt average power, and a 5-kc bandwidth. The device will weigh about 5 lbs. and have a S/N ratio of at least 10 db at maximum range, according to IBM.

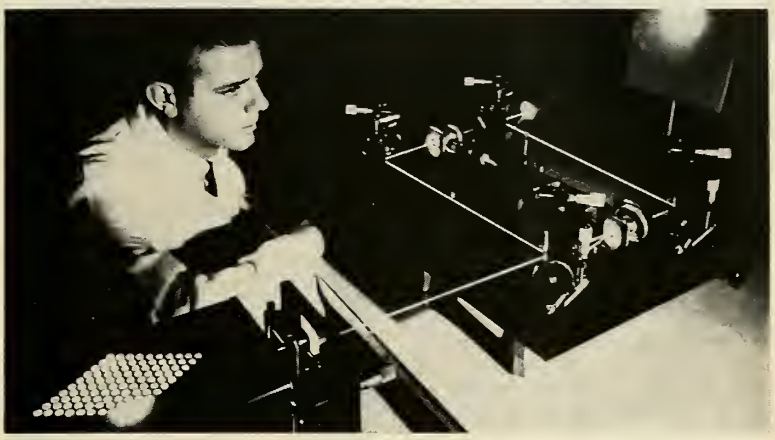
The optical receiver will be a folded, large area (2- to 3-ft. dia.) reflector on a *Nike-Ajax* pedestal slaved to an FPS-16 tracking radar. Metric Systems Corp., Ft. Walton Beach, Fla., is modifying the GFE pedestal for IBM.

A pulsed laser will serve as the beacon light source for ground station acquisition.

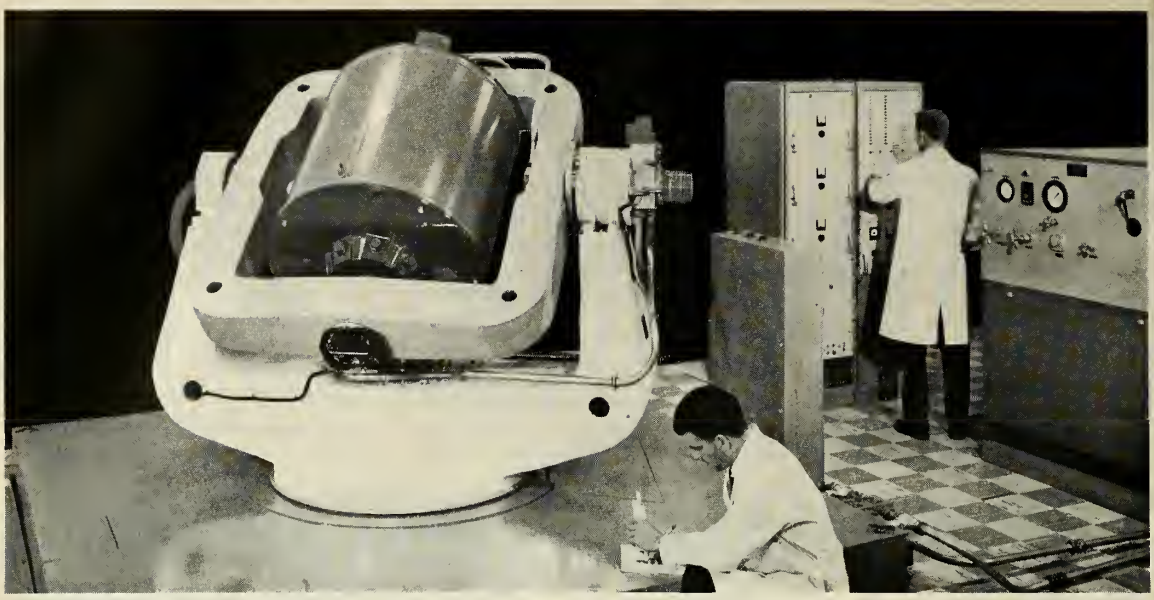
• **Center activity**—Among the NASA centers, MSFC, GSFC, JPL, MSC, FRC and Langley administer in-and-out-of-house laser efforts in about that order of involvement. The new Electronics Research Center eventually will get heavily into the picture. MSFC is now engaged with Carnegie Tech in a study of the broad generic class of semiconductor lasers. The Huntsville center is also doing the bulk of the optical hetrodyning efforts, and last week announced a $78,000 contract to the Sylvania Electric Products Subsidiary of General Telephone and Electronics for a new superhet receiver to be delivered in March '65. Other MSFC contracts are with ITT for a study of coherent transmission, and with Philco for coherent detection using indium arsenide detectors.

MSFC is also the current focal point for NASA development of laser cooperative rendezvous systems, and the center this month is expected to select a contractor for development of an experimental laser-ranging and angle-measuring system.

JPL is looking mostly at gas lasers, focusing in particular on the 8- to 14-micron window. The Goddard effort is centered on ground-based tracking and laser comsat (*MIROS*) programs. Marshall is doing in-house studies, with some MIT support, on laser re-entry communications. Langley is engaged in in-house laser back-scatter instrumentation. ■



LIGHT FROM helium-neon gas laser (left) is shown passing into and through Electro-Optical Systems' interferometric module where it is split and controlled in relation to the original beam. Split and controlled beams are seen at top of photo. Unit may be important component of future optical radar surveillance systems.



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OPTICS

Range Instrumentation Calls for More Use of Aircraft, New Ground Systems

Existing instruments are being modified or replaced; trend to airborne platforms shows demands of improved accuracy

TWO CONDITIONS dominate the field of range electro-optical instrumentation today: an increasing emphasis on the use of airborne platforms to perform missile flight test observation and recording and a general need for updating or replacing existing ground systems.

The principal instruments in use today at all ranges are still the Contraves and Askania cinetheodolites, IGOR and ROTI long-focal-length photo telescopes, and the ballistic camera.

Both Contraves and Askania systems are being converted, or are being replaced with new systems to provide digital readout of azimuth and elevation angles. IGOR's and ROTI's, at several ranges, will be improved with the addition of image intensifiers. Ballistic cameras are experiencing the introduction of shutter time synchronization (Link Div. of General Precision, Inc., is developing such a system to synchronize eight Wild BC4 cameras at White Sands Missile Range).

Greater use of infrared trackers and television cameras can be seen at all the ranges in support of the larger primary optics in acquisition, control and reacquisition following loss of target.

The move to the use of aircraft reflects the growing need for improved accuracy in tracking and event recording. Instruments located above 35,000-40,000 ft. are beyond 80% of the Earth's atmosphere and thus avoid the attenuation experienced by ground-based optics.

As an indication of instrumentation trends, many of the major development programs and systems are presented below for Atlantic Missile Range, White Sands Missile Range, Naval Ordnance Test Station—China Lake, Pacific Missile Range and El Centro.

ATLANTIC MISSILE RANGE

The Atlantic Missile Range, directed by the U.S. Air Force as a National Range, carries an extremely broad range of electro-optical systems in its total inventory. As NASA's use of the range increases and the annual flight test schedule becomes more and more crowded with a variety of experiments, more advanced range instruments must be acquired. The following is a summary of the more significant new systems now operational or soon to be.

● **Project Fire tracker**—A 36-in. telescope fitted with spectrographic instrumentation and a recording camera has been mounted on a Navy TIM mount (see NOTS, China Lake, section below) and installed on Ascension Island.

Designed to study re-entry phenomena in NASA's Project Fire, the instrument is one of the largest tracking units now in operation. It was developed for NASA by the J. W. Fecker Div. of American Optical Co.

It records photographically over the range of 4,500 to 9,000 Å in the first order spectra and 2,250 to 4,500 Å in the second order spectra. It also records a discrete band of radiation in the infrared which ranges from 0.9 to 1.5 microns wavelength. The infrared recording is done electrically on magnetic tape.

The system is fitted with an automatic tracking system, automatic exposure and automatic acquisition to radar or some other external tracking device. The device is a forerunner of larger-aperture optical tracking devices that will appear on ranges in the next few years. These devices will be held on tracking mounts that provide angular readout to better than seconds of arc. The mounts will use optical tracking error-sensing equipment.

● **CW laser tracker**—OPDAR, Optical Direction and Ranging, will be the first U.S. continuous-wave laser missile-tracking system. In second-phase development now by Perkin-Elmer Corp. under a $250,000 Rome Air Development Center contract, the advanced tracker is due for installation at Cape Kennedy next year.

The system is being designed to provide accurate early-phase trajectory measurements of missiles up to 60,000 ft. from the Atlantic Missile Range. OPDAR outputs of missile position, velocity and acceleration will be provided in real-time use by Range Safety. Also, the data will contribute to post-flight performance evaluations.

Designed as a cooperative tracking system, the gas-laser transmitter will produce a 100-mw visible beam (6,328 Å) that will be reflected by a missile-borne mirror to the ground receiver. A second laser, providing a coarse beam, and an infrared tracker will be used for re-acquisition if primary track is lost.

Feasibility of this approach was shown by P-E in an earlier $250,000 AF contract referred to as PIRT, Precision Infrared Triangulation.

● **TV theodolite**—A Real-Time Optical Tracker developed by Measurement Systems, Inc., for NASA provides target angular position to an accuracy of 5 seconds of arc, the firm claims.

The search-acquisition telescope is a 2-in.-dia., 20-in.-focal-length instrument; the track telescope employs quartz-invar cassegrain optics with a magnifying transfer lens. The latter measures 6 in. in diameter, has a 200-in. focal length and is confocal with the

search-acquisition image. The TV camera tube is mounted atop the telescopes.

Tracking mount and telescopes together are only 36 in. high and total weight is 13 lbs. Electronics are packaged separately in three cabinets.

Output from the system can be fed directly to a digital computer for real-time processing and the field of view is deployed on a TV monitor.

The system was installed at Cape Kennedy last fall.

● **Digital theodolites**—Seven new Contraves EOTSC Cinetheodolites providing digital readout in azimuth and elevation have been ordered by AMR from J. W. Fecker for delivery this year. Designated the Model E, the updated instrument requires a single operator and includes a semi-automatic film reader as part of the system. Az and El angles are provided by a patented dual circle-projection digital optical encoder.

The result, says Fecker, is that film reading time has been reduced from 50 sec./frame to 0.8 sec.

● **ALOTS award**—A precision airborne photographic system for use at AMR will be developed by Nortronics Div. of Northrop Corp. under a recently announced $1-million USAF contract. Called the Airborne Lightweight Optics Tracking System (ALOTS), it will be designed for installation in a JC-135 aircraft.

Operated at altitudes of roughly 40,000 ft., the camera will be used to film missile launches through stage separation and also cover re-entry. In the 14-month R&D program, Nortronics will produce and test the integrated system, which will include a manual and auto-tracking system, a photographic system and a control console.

The tracking system will cover from ±30 degrees in azimuth and from −7 degrees to 90 degrees elevation relative to the aircraft. Contract performance requirements call for two seconds of arc resolution on commercial film. Az and El tracking rates will be 15 degrees/second throughout the tracking limits.

The system will include a 200-in. focal length telescope, a 70-mm. camera operated at 80 frames/sec., and two vidicon sensors for tracking.

The entire instrument assembly will be located on a two-axis gimballed platform with an external pod. The manual tracking station will be separate from the automatic tracked system in the pod.

● **IR measurement system**—Two IR Measurement Systems—one to be located near Cape Kennedy, the other on Ascension Island—will be used to acquire radiation histories of AMR-launched missiles from near lift-off through re-entry.

Under development for the last two years by AMR Development Div. and Pan American World Airways, the system is being integrated by Metric Systems Corp.

Heart of each system is a high-resolution IR tracker accurate to better than ±0.2 mil in Az and El. Spectral measurements from 1 to 14 microns will be made by a dual-barrel, 12-in.-aperture IR radiometer using lead-sulfide and thermistor detectors. A photometer will cover the region from 0.24 to 1.0 micron in six distinct wavelength intervals.

Supporting instruments include an IR scanner (for resolving radiation source location), a boresight camera and electronics and tape recorders.

● **TRAP I & III**—TRAP (Terminal Radiation Airborne Program), as directed by the Air Force, is concerned chiefly with the study of re-entry phenomena and development of useful optical techniques for the furtherance of discrimination of re-entering bodies.

TRAP I is a project being performed by GE's Missile and Space Div. for the USAF Ballistics Systems Div. that involves the measurement from aircraft of electromagnetic radiation associated with re-entry vehicles.

Operational since 1961, the system has been used primarily at AMR and PMR for the study of terminal events. It is expected to be used in the future at WSMR.

The instrumentation, installed in a pod atop a C-135 jet aircraft, includes three (one for IR) D. B. Milliken DBM-4 16-mm, f/1.8 high-speed cameras; a Traid Model 75A cinespectrographic camera (35 mm, f/1.4); an Aerojet-General T-51D two-channel radiometer; and two Traid KB3-A 16-mm gunsight cameras (one for IR).

TRAP III, a similar program, is being handled by the Bendix Systems Div. for USAF Aeronautical Systems Div. Equipment for TRAP III, due for installation aboard a C-121, was delivered to ASD earlier this year.

The Bendix system is located under a row of gun turret-type domes atop a modified C-121. The domes are isolated on a platform to help minimize aircraft-generated vibrations.

● **Nighttime missile tracker**—An airborne TV auto-tracking system developed by the Norden Div. of United Aircraft Corp. will be used for night observations of re-entry phenomena.

Developed under an Air Force contract with ARPA support, the system has been delivered to MIT's Lincoln Laboratory for operational use. The tracker essentially will be used to automatically point other optical and electronic systems required to record re-entry phenomena.

The entire system includes TV cameras, a zoom lens and relay optical system plus tracking electronics and two video monitors.

The system will be installed on a C-135 jet. The camera will be directed via radio by ground-based radar and computer systems for acquisition.

● **Other AMR requirements**—In addition to the major electro-optical systems described above, AMR also is making the following modifications or additions to its already large instrumentation inventory:

—Adding image intensifiers to Perkin-Elmer ROTI (Recording Optical Tracking Instrument) and J. W. Fecker's IGOR (Intercept Ground Optical Recorder) telescopes to increase range and improve photo quality. Also, the IGOR's will be modified for installation on mobile mounts.

—Developing a new, lightweight optical beacon for daytime use capable of extending existing camera range and helping improve accuracy. A second will be a miniaturized version for night operations only.

WHITE SANDS MISSILE RANGE

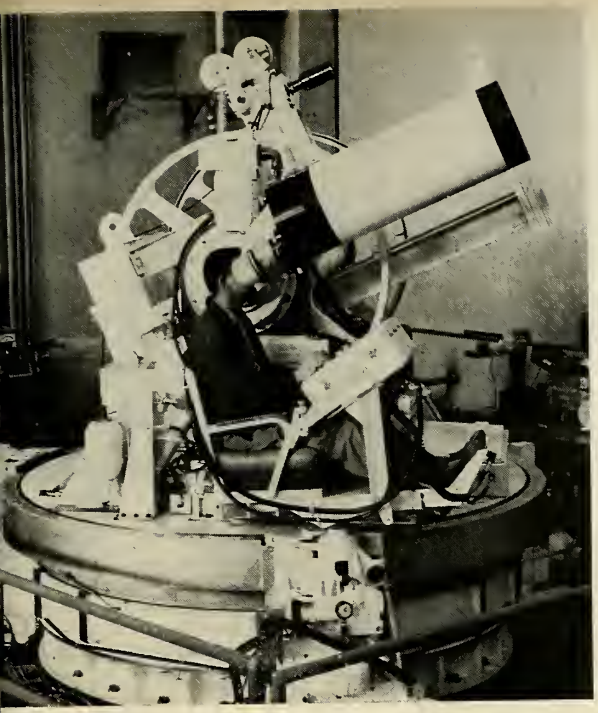
White Sands Missile Range, operated by the Army for the Department of Defense, conducts its own basic research programs. In contrast to ranges like PMR and AMR, its most severe optical tracking problems in the past have occurred in the launch phase—in tests on very high-acceleration missiles. It is now, however, engaged more and more with the study of re-entry phenomena.

● **Super cinetheodolite**—A new cinetheodolite using a measurement principle developed at White Sands is expected to give an order-of-magnitude improvement in tracking accuracy. This instrument, the White Sands Cinetheodolite, is expected to give an angular accuracy of 3 to 5 secs. of arc, compared with the 20-30 secs. obtained with existing Askanias.

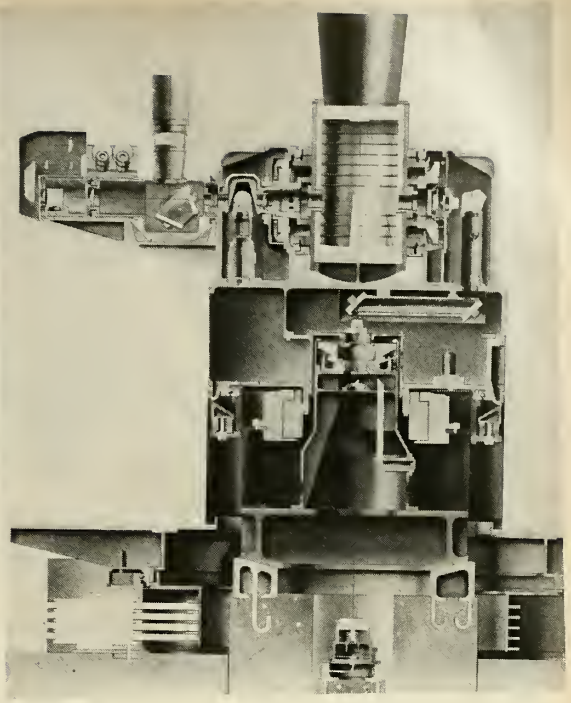
It will be the first American cinetheodolite and, if successful, may be used on all U.S. ranges, procurement beginning in 1967. Various types of ancillary equipment, such as the NOTS tracking error detector, will be used with this instrument.

The White Sands Cinetheodolite developed out of work that aimed to provide cinetheodolites with a self-calibrating capability by transmitting local vertical references through the optical system. The result, in the new instrument, is that any deflection of the mechanical parts of the telescope causes an equal movement of the fiducial marks from which target position is measured. The prototype unit being built by Keuffel and Esser Co. has a 12-in. aperture and 100-in. focal length.

● **Project Glow**—An Optical Re-Entry Instrumentation System will be developed by Perkin-Elmer under an Army Missile Command contract announced last February. To be part of



NOTS TRACKING Instrument Mount points a J. W. Fecker Div. 8,000-lb. telespectrograph at re-entry bodies in Project Fire observations from Ascension Island. Here it is being checked out at China Lake.



WHITE SANDS Cinetheodolite being developed by Keuffel and Esser will provide order-of-magnitude increase in accuracy over present systems. Measurements made by instrument will be independent of mechanical deflections in the optics.

Project Defender, the system (designated Project Glow) will provide IR, visible and UV radiation-signature measurements of various shaped re-entry bodies from White Sands Missile Range.

System instrumentation will include radiometers, spectrophotometers, a spectograph and a pedestal-mounted autotracker (IR, visible), TV camera and monitor and a boresight camera. A Perkin-Elmer ROTI missile camera will also be included to obtain re-entry photographs.

Two ground instrumentation facilities will be developed.

● **Re-entry spectrograph**—As a part of Project PRESS, a new re-entry slitless spectrograph developed by Baker-Nunn is being used at Kwajalein Atoll to obtain radiation characteristics of ICBM warheads. A key element in the design of the instrument was the use of gearless torque motors, developed by Inland Motor Corp. Computer-controlled, the motors position the instrument in azimuth and elevation at acceleration rates of 20 degrees/sec.^{2}. Position tracking error, reportedly, is less than one minute of arc/0.1 sec.

The use of gearless torque motors, developers claim, was the only method available to assure smooth positioning rotations sufficient to avoid spectral-image smearing.

● **TRAP V**—Located at Holloman AFB, TRAP V is a measurement station employed to collect re-entry phenomena from experimental vehicles launched from WSMR. Instrumentation includes a Williamson and Co. spectral ballistic camera, three Kodak K24 cameras (one empoyed as a fixed-trajectory ballistic camera for visible/IR range, one as an IR spectral ballistic camera, and one unmodified), one D. B. Milliken DBM-5 high-speed motion-picture camera, a GE cinespectrograph, two Bell & Howell Eyemo motion picture cameras and a Philco image orthicon.

● **Mobile mount**—In conjunction with PMR, White Sands has developed a mobile cinetheodolite mount that is now being procured in quantity. Seventeen are required: eight for White Sands, five for AMR, and four for PMR. Three units are already in use in PMR.

● **Data reduction**—One of the operational problems of concern to WSMR is the time taken to reduce optical data. This can average two weeks. A recent study has shown that under optimum conditions the very least time delay that can be expected is four days, and there is considerable thought being given to the value of real-time readout.

"This whole area of film readers is a very fruitful area that we are looking at real seriously," commented C. W. Mullis, Chief of the Optical Systems Branch. "Industry has not done much in this field and 100 to 300% overuns in developing instruments under contract is typical of the situation in this field."

The crux of the question is how much is real-time readout worth for optical range instrumentation. With over 80 units to be re-equipped, real-time readout at White Sands could cost $10 million.

In the general area of film readers, an order-of-magnitude increase in accuracy is required.

● **Error accumulations**—Another area of study at WSMR is the combined effect of natural errors on tracking instrumentation, to determine whether increased tracking accuracy is really desirable. Effects to be taken into account include turbulence, geodetic anomalies, refractive anomalies, gravitation anomalies, propagation velocity uncertainty.

Results of the study are expected in a year and will provide guidance both for basic research to reduce these effects and for realistic design specifications.

● **Early launch problems**—Problems facing WSMR in the early launch phase are that accurate tracking data and close-up pictures are required from missiles accelerating at rates in excess of 100g.

For collecting yaw data, a pro-

grammed single-axis mount capable of 12 radians per second in one axis has been developed. The unit is placed directly under launch azimuth and is initiated from the missile lift switch. Precalculation of acceleration values in successive segments of flight has proved quite successful. Generally three of these cameras cover a launch, replacing 30 to 40 fixed-field cameras.

A lens in a quartz barrel is being developed at NOTS, for use in an early launch phase application. This telescope is to be manually tracked (although some aid in tracking will be needed) at rates up to 2 radians per sec. Some work is starting on the use of infrared devices to assist in tracking.

● **GORID**—The Ground Optical Recorder for Intercept Detection (GORID), developed at WSMR, uses an IGOR 70-mm tracking telescope with a hydraulic servo system that gives good pictures of small missiles at long ranges, together with accurate angular data. One prototype unit is being evaluated in the field. It has an 18-in. aperture, a focal length that can be adjusted from 90 to 500 in., automatic exposure control and automatic focusing. Angular readout to 1 part in 200,000 can be recorded on magnetic tape.

Being installed at WSMR are eight ballistic cameras with internal sky screens for day use.

NOTS, CHINA LAKE

The U.S. Naval Ordnance Test Station, China Lake, Calif., is engaged in a number of advanced developments that include a television automatic tracking system, laser ranging, high performance tracking mounts, a missile yaw detector, and sounding rocket instrumentation.

● **TV tracker**—A new television automatic tracking system under development at NOTS employs a TV camera attached to the same mount as a tracking telescope to provide coordinate information that enables the telescope to follow the target as long as it can be seen. The TV system provides a readout that indicates the target offset from the optical axis of the telescope (the tracking error).

A laser rangefinder is being procured and, when coupled with this system, will provide range information. The result will be an installation that can obtain complete range and bearing data from a single station.

The present system uses a standard Cohu Kintel 545-line closed-circuit TV system and provides an angular accuracy of 15 seconds of arc. A 945-line high-resolution system has just been completed.

A tracking gate is placed around the target by counting the number of lines before the first edge of the target is encountered and then measuring the distance of the edge along that line by means of an 8-mc. counter. These data are recorded directly on tape for processing on an IBM 7090. They can also be presented in real time for automatic tracking.

● **Other laser research**—NOTS is carrying out research aimed at improving laser efficiency by phosphor techniques. Also, the influence of junction flatness in GaAs lasers is being investigated.

● **Computer control**—For target acquisition of optical tracking instruments, NOTS, in cooperation with IBM, has developed a system that uses vehicle telemetry to measure vehicle position and convert this data in an IBM 7094 to give real-time tracking commands for each of eight Askania cinetheodolite stations.

Position of the vehicle is measured by the *Missile Intercept Data Acquisition System* (MIDAS), by use of electronic interferometer techniques. Readout accuracy is ± 50 parts per million. The IBM 7094 takes this data, and information from tracking radars, in real time and develops tracking instructions that appear as lights in the tracking oculars of the Askanias. Instructions are displayed as right/left azimuth and up/down elevation lights in the periphery of the field. The operator's task is to move the camera to keep the lights extinguished.

● **Telespectrograph mount**—Most recent tracking-mount development at NOTS has been the design of the 32,000-lb. Tracking Instrument Mount (TIM) that has carried an 8,000-lb. telespectrograph for project Fire, at Ascension Island. The mount has been designed to have a high performance with heavy instruments and it features very flexible tracking characteristics. The servo system includes a PACE computer that can adjust the system to suit the operator. There are four main modes of control: manual; target acquisition, using radar data; aided tracking; and diode function-generation, in which a programmed positioning routine is provided for checkout.

Design calculations indicate an overall accuracy of 5 seconds of arc. The mount has been designed for velocities up to 60 degrees per sec. and accelerations of 180 degrees per sec.^{2} In checkout, the system was tested at $\frac{1}{75}$th of sidereal rate, indicating a dynamic range of over one million to one.

● **Project Hi-Tab**—NOTS is also providing sounding-rocket instrumentation for project Hi-Tab, part of project Tabstone, which aims to find out target and background spectral characteristics. Using *Aerobee* rockets, Hi-Tab is concerned with ultraviolet and infrared measurements. Payloads are designed either for background or target measurements. For the latter type, a target acquisition system is provided.

PACIFIC MISSILE RANGE

Optical instrumentation on the Pacific Missile Range is used for launch tracking and for re-entry studies. Increasing use is being made of computerized tracking, but the human operator will be retained in the tracking loop because of his superior ability to identify and discriminate between targets.

As instrument sophistication improves, however, certain failings of human operators are becoming more apparent. The human factors study at the University of California at Los Angeles (NOTS is the lead range for this) is one approach to this problem. A second is the development at PMR of a training simulator for cinetheodolite operators.

One of the most advanced tracking systems on the range is a unique setup of two large tracking telescopes on Kwajalein Island. These are remotely slaved by a digital system that pre-tracks them in accordance with radar data.

The telescopes are 24-in.-aperture, 480-in.-focal-length instruments, and are coupled to a computer over standard telephone lines. One instrument is 9 miles from the computer.

Radar data to the computer are updated to give a predicted position, corrected for parallax. Also, a hyperbolic function of slant range is generated to provide digital focusing commands.

Digital data from the telescope indicate pointing angle. This is compared with predicted target position to yield an error signal that drives the telescope servo. The computer compensates for transmission delays in the communication system.

PMR also has recently installed three Mobile Tracking Stations—jointly developed with White Sands. These are installed at Eniwetok, and were transported there by aircraft. They are completely self-contained stations, capable of mounting an Askania cinetheodolite or a Mobile Optical Tracking Unit (MOTU). Highly specialized trailers with raised or lowered torsion bars for mobile or stationary operation are used.

EL CENTRO

The Naval Air Facility at El Centro, Calif., is employing a new data processing system to handle the mass of information collected by five Askania tracking cameras during parachute tests. XYZ coordinates on specially scaled film are fed into a General Electric GE-225 computer for analysis. Completed test evaluations are available in 24 hours, compared to the three to seven days required previously, GE said.

The facility is currently handling about 80 test programs, including *Apollo* and *Gemini* recovery systems. ■

Guidance and Navigation Progress May Come in Detectors and Read-Out

Lasers are winning more attention for a variety of uses; NASA seeks more realistic mating of accuracies and needs

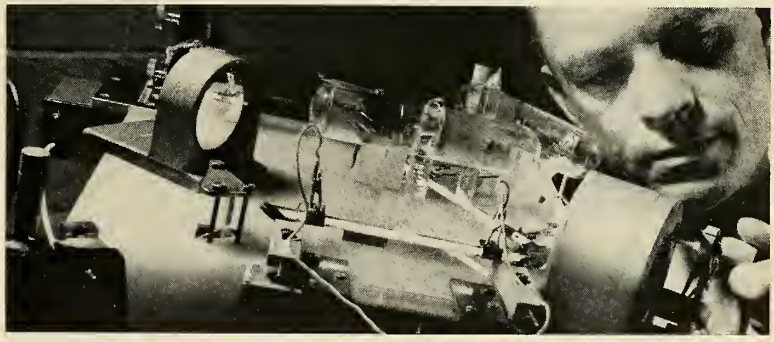
IMPROVEMENTS in photo-detectors and optics position read-out devices could yield the next round of advances in electro-optical guidance and navigation systems. In many cases, say the experts, precise pointing accuracies are being undermined because it's impossible to achieve equivalent performance further back in the system involved.

Matching detector sensitivities and angular measurement accuracies to the new and sophisticated tracking systems will have important effects—for example, on high-accuracy pointing systems for spaceborne scientific observatories and on the development of daylight star tracking systems for mobile missiles.

An increasing amount of attention is being paid to lasers, both as components (rate sensors) and as major subsystems such as optical radars for rendezvous guidance and altimetry. Air Force and NASA support is growing (see laser article, p. 27). In addition, there is fresh emphasis on use of the laser as the light source and modulator in optical computers, which may be associated with G&N systems in which lasers are already aboard for other roles.

Another item of potentially wide implication for the industry is NASA's "new look" at its far-ranging guidance system needs; the space agency has an eye toward more realistically matching system accuracies with mission requirements.

NASA scientists told M/R they will first make a close study of all their missions to see what space-based tracking accuracies are really needed—if the guidance system is not, in fact, overdesigned to achieve those accuracies.



LASER GYRO built by Honeywell's Military Products Group research department is a helium-neon device operating at 1.15 microns. The gyro has a triangular configuration utilizing three flat mirrors and is mounted on a quartz base.

Space agency scientists are keenly interested in cutting down complexity (and thus failure potential), and there is some feeling that G&N needs for many programs may well be met with far less sophisticated hardware.

Many experts believe there will be a steadily increasing demand for stellar or planetary seekers and trackers to augment or possibly even replace inertial systems for future very-long-duration deep-space probes and for military missiles requiring rapid boost-phase, mid-course, or terminal guidance corrections. Whereas these systems will place a premium on accuracy and reliability in an unmanned environment, new money and effort will also be focused on manual and semiautomatic electro-optical systems which will place man substantially in the G&N loop, using relatively simple devices aboard such vehicles as space stations and ferry spacecraft.

Development of integrated circuitry, which will benefit the entire G&N field, may particularly favor increased use of small onboard TV systems for G&N read-out, display, missile terminal guidance, pattern recognition systems, and to ease conventional telemetry requirements. Westinghouse and RCA have pioneered in development of small, low-power systems. RCA will supply a small set for *Apollo* display and lunar surface exploration.

● **Detectors**—Among the new detectors under development, most attention is being directed at new semiconductor-type solid-state detectors—often arranged in finely divided mosaic arrays—in which the individual elements can be singly addressed and amplified in new and rugged vidicon imaging tubes and in new electron multipliers such as Bendix's "channeltron" tube (M/R, Oct. 21, p. 24).

The conventional photomultiplier

tube, which continues to have wide use, nevertheless has problems of high voltage, large size and vibration sensitivity. Many designers feel that these factors eventually will demand its replacement by other methods. In addition, the newer detector arrays can detect star fields—rather than just a single star or point light source, as is commonly the case with photomultipliers. This should lead to increased tracking reliabilities.

Solid-state detectors, NASA scientists add, will remove mechanical scanning and yield higher outputs to reduce requirements for servo loops and amplification, allowing detector output to feed directly into control systems. They say the solid-state materials appear to look good for star tracking against very high ambient light backgrounds; this will aid development of new daylight star trackers.

Solid-state detectors should also be employed in new Sun sensors with which NASA is seeking to study particular portions of the spectrum below 1,100 Å in the ultraviolet and 25-50 microns in the infrared.

Wide use also appears to be in store for the Bendix channel multiplier or "channeltron," an image dissector with a unique electron multiplication scheme which yields high gains with little complexity. NASA will use this detector for X-ray and UV detection aboard an *OSO* satellite and is also reportedly considering its use as an on-board orbital plane determination experiment and as a possible pattern recognition system component.

● **Transducers**—While the ability to build precision pointing capabilities into telescope systems has increased steadily in recent years, efforts to develop the ability to measure the relative angular orientation of the scope have run into formidable problems.

Fine pointing systems for several space systems under development are expected to be capable of detecting pointing-error signals on the order of a second of arc or better. However, the current state of the art in the development of angular transducers is now realistically set at about 5 secs of arc, according to tracking system designers, for about a 4-in.-dia. unit. Designers say that keeping the size down is highly important, and it has become increasingly difficult, due to power and thermal stability problems, to better the accuracies with these size demands.

Several manufacturers have made important progress in getting even this far, the designers report, but there are still substantial rewards awaiting the development of even smaller higher-accuracy devices which can be coaxially installed on the optical shaft to avoid use of gears and that have either an inherently digital output or can be easily digitized.

NASA officials point out that even though one-sec.-of-arc accuracies are "no problem for the instrument," about 5-10 secs. of arc represents the current overall ability to track a star, allowing for all of the vehicle instabilities.

● **Closer to the Sun**—There is also an expanding market for new sensors which can track stars of higher magnitude and systems which can track stars nearer alignment with the Sun. Current state of the art permits tracking stars of about 2.5 magnitude. About another magnitude would probably insure fulfilling all of the envisioned navigation needs. Currently a 2.5 magnitude star can be tracked to within about 30 degs. of the Sun, experts report.

NASA scientists would like new star and planet trackers to be able to track stars of this order to within about 5 degs. of the Sun. The problem is severe, they point out, and not only in detecting the stellar energy. At planetary distances, the solar light is so intense that it presents formidable reflection problems for spacecraft designers. Masking is very difficult. Everything on the spacecraft must be kept out of the tracker's field of view to cut down on local reflections.

In addition, new effort will be needed on coatings for optics, new anti-internal reflection schemes, and on high temperature (in excess at 1,500°F) survivability for electro-optical systems launched into the vicinity of the Sun.

● **Horizon sensors**—The next year's flight activity within Langley's Project D-61 and NASA's Project Scanner will be vitally important to industry engineers designing horizon sensors for space agency vehicles.

Both programs are aimed at being able to define just what the Earth and its horizon actually look like to a far greater degree than is currently known, and at establishing optimum wavelengths with which to measure it. As one scientist points out, "industry is capable of designing some excellent sensors, except the design is being based on a false input."

Largely because of this, there is generally an order-of-magnitude difference between what developers and users say is state of the art in this field. Industry engineers say $\frac{1}{10}$-deg. accuracies are possible; NASA says 1 deg. is more like it, and adds, "only under optimum cloud conditions."

As an example of what can go wrong with these outputs because of a lack of the best design knowledge, NASA points out that during one of the *Mercury* flights the horizon sensor registered a "30-deg. tilt" when flying over a hurricane.

The D-61 program, commonly lumped with Scanner but actually a separate preliminary program, has had two shots already, one of which failed. The next launch is expected this summer. This shot will test a new star mapping device which will be used later on *Scanner* for attitude-reference data.

The D-61 shot will explore a UV and 3 IR bands in an attempt to determine optimum wavelengths. Scanner vertical resolution will be on the order of $\frac{1}{4}$-deg. and will explore two IR bands at 14-16 microns and 20-40 microns. First shot is planned early next year. Honeywell is building the three spacecraft (including one back-up). NASA is hopeful that Scanner shots will verify theoretical work indicating that the 14-16 micron band may be optimum for horizon-sensing operations.

Among the improvements both the military and NASA are looking for in horizon sensors is a move away from systems using rotating parts, such as prisms, to electronically-scanned solid-state systems. They will also explore "pulling back on accuracy in the interest of simplicity and longer lifetime."

For space-station use, horizon sensors should be able to operate for "a couple of years." For weather satellites, scientists say at least a year will be required.

Examples of new detector techniques coming to the fore include the evaporated thermopile technique developed by Barnes Engineering Co. (M/R, May 27, 1963, p. 25) which will go into a Goddard-STL satellite, and several proprietary methods including solid-state semiconductor photomultipliers and thin-film semiconductor detectors also under development in industry.

The more conventional thermistor bolometer is also being refined continually. A series of widely used (*Agena-D, Gemini,* and *OGO*) horizon sensors of this type has been developed by the Advanced Technology Laboratories Div. of American-Standard (M/R, Oct. 7, p. 52).

Improvements in Earth horizon sensors should also open up new avenues for planetary horizon sensors.

● **SOA projects**—Among the current U.S. missile/space programs, the following are reported as pressing hardest against the state of the art in electro-optical guidance and navigation systems:

—The *Orbiting Astronomical Observatory's* six star trackers (M/R, Oct. 7, p. 67), supplied by Kollsman Instrument Corp., each have delivered, composite (two-axis) angular accuracies of 30 arc secs. which will aid in orienting the entire 3,000-lb. *OAO* to within 1 arc/min. Fine pointing systems built into *OAO* experiments will develop pointing accuracies relative to a partic-

ular target within fractions of a sec. of arc. For example, the *Goddard Experimental Package* (M/R, March 4, 1963, p. 22) going into the second *OAO* will be capable of fine pointing to about 1/10 arc/sec, according to Kollsman Instrument Corp. scientists, who are also developing this package and the pointing system for NASA. The Princeton University experiment, being developed by Sylvania with Perkin-Elmer Corp. supplying the optics, will fly on the third *OAO* and is expected to detect pointing errors on the order of 0.1-0.01 arc sec.

—Key to the pointing accuracy expected on-board the *Advanced Orbiting Solar Observatory* being developed by Republic Aviation Corp. is a new Sun sensor being built by Honeywell (M/R, Oct. 7, p. 67). It is to achieve a pointing accuracy of 1-2 secs of arc when oriented within a 40-arc/min. square centered on the Sun, and an accuracy of 1 minute of arc when outside this square and inside a 10-deg. square centered on the Sun. The pointing capability reportedly represents an order-of-magnitude improvement over the first-generation *OSO*. *AOSO* will also be the first satellite equipped with a raster scanning system, somewhat akin to a TV video tube, for solar-disc electromagnetic spectrum reconstructions.

—Guidance tracking accuracy for the *Stratoscope II* (M/R, March 11, 1963, p. 37) unmanned balloon-borne telescope system, according to Perkin-Elmer Corp. engineers developing the system for the joint NASA-ONR-NSF team, will allow images of stars to be fixed in the photo plane to better than 1/50th of an arc sec. for up to an hour's duration. Guide stars for the system can be as dim as 9th magnitude. Two guide stars are used to hold the object in the image plane. Each star lock-on system consists of a unique four-way reflective beam splitter and four RCA photomultiplier tubes.

—*Apollo* optical subsystem, (M/R, Oct. 7, p. 54) also being developed by Kollsman, is another of those said to be pressing the technology, especially in read-out accuracies and increased use of beryllium in the structure. The system, however, had been originally designed as a straight optical system with visual sightings. It is now reported that auxiliary photo-electric detectors will be provided to ease the crew requirements in this area.

—Among other NASA project of interest is the "dog-on-the-leash" system, first reported in M/R, Nov. 25, pp. 43-44. In this approach, an electro-optical spacecraft guidance system is actually separated from the spacecraft on its own platform attached only by a connecting cable. Though this idea would have many advantages, it has also reportedly run into problems in development of the electrostatically suspended gyros which would be used with an advanced electronically-scanned optical tracker. Preliminary work on the optics is reportedly nearing completion at the Ames Research Center, but NASA officials say that ground tests with a breadboarded system are still more than two years away.

● **Star trackers**—Within the military, there is a pressing need for stellar-inertial systems currently represented by the *MMRBM*. Through all its continuing troubles as a weapons system, *MMRBM's* guidance development has never really been challenged. The reason is its applicability to any new mobile-type medium-range missile system the U.S. or NATO might develop. Its use has also been postulated for DOD's Controlled Orbit and Precision Recovery Program, in addition to other possibilities in the medium-range missile program, such as a two-stage *Minuteman*.

Basically, the stellar-inertial system of the *MMRBM*-type would allow rapid firing of missiles which had been moved quickly and had only coarse data for the inertial portion of the guidance. Inclusion of a star tracker which could, probably within the first 100 secs. of flight before booster burnout, take rapid fixes on two stars would enable accurate up-dating of the inertial system during the powered flight phase.

General Precision, Inc., Aerospace Group is the prime AF contractor on *MMRBM* guidance, and the Nortronics Div. of Northrop Corp. is supplying the star tracker assembly, designed around a telescope and vidicon tube. Tracker accuracy is believed to be on the order of 5-10 secs of arc, probably including read-out limitations.

Need for trackers of this type, able to function rapidly with on-board digital computers and during daylight, has also spurred other effort within industry.

General Precision, which, although prime contractor for *MMRBM* guidance, is not supplying the star trackers, also has under company development a new daylight tracker for which it claims accuracies of better than 5 secs. of arc.

GPI points out that position data can be used either in a star sensing mode—in which coordinates are fed directly into a computer which in turn calculates the platform error, or in a star-tracking mode—in which the data are fed to the gimbal servos which drive the stellar sensor so that the optical axis of the sensor is continually aligned with the star line of sight.

Heart of the GPI sensor is a proprietary "twin-V" photo-conductive detector which, engineers report to M/R, permits locating a star of 1.2 visual magnitude in less than 3 secs. with a sky background of 1,500 ft. lamberts.

An optical system collects and focuses the star energy which is then scanned across the field of view. The detector and an optical linear encoder are rigidly attached to the scanner; the encoder permits reading of the scan mechanism at the moment of detection.

Associated right/left logic determines the direction of motion of the detector. These pulse lines, GPI says, are then fed into the star position logic, which consists basically of counters and registers. The counters continuously monitor the position of the twin-V detector, and a star pulse signal transfers the counter information into storage registers. The twin-V configuration, says the firm, enables both X and Y information in the focal plane to be obtained from a one-dimensional scan.

● **Space stations**—Several techniques are also under study by industry and government agencies for implementation of space-station navigation systems, primarily station-keeping devices. Cost is expected to play a major part in choosing a system. Possible contenders for this role include:

—A digital command system somewhat akin to the *Gemini/Agena D* hardware (M/R, July 22, p. 32; May 4, p. 42), in which the space station is heavily dependent upon ground-derived-and-transmitted data to up-date on-board systems.

—An improved version of the *Gemini* guidance and navigation system (M/R, Oct. 7, p. 52).

—An Airborne Ranging and Orbit Determination System under study by NASA's Marshall Space Flight Center, which basically consists of range and range-rate data derived in a trilateration technique using a series of ground-based transponders.

Among other methods being studied in industry is a relatively simple space-borne optical system, designed by IBM Federal System Div. engineers, said to be capable of acquiring geodetic or orbital navigation data by simultaneous observation of ground-based "benchmarks" and stellar background along a single optical axis. Use of this single-axis method, according to IBM, eliminates shaft-to-digital read-out errors and simplifies operations. The system is independent of Earth links. It sights on a benchmark on the Earth's surface. Another sighting is simultaneously taken along the outward extension of the same benchmark-to-vehicle LOS, and a single indentifiable star is observed in the field of view. The angle between the star and the sighting axis is measured, providing basic navigation data, and the operation is repeated to develop orbital parameters. ■

ELECTRO-

OPTICS

Scientific Instrumentation Business Thrives Independent of Program Cuts

Field's growth outstrips electronic industry; vacuum technology sets the pace; Stratoscope II and OAO programs will revolutionize astronomy; in-space assembly of lightweight structures under study

CONSENSUS OF EXECUTIVES of instrumentation firms visited by MISSILES AND ROCKETS is that the scientific support needs of the nation's space and defense efforts will continue to provide a good market for their products.

It is felt that any cutback of a major program will not be too critical to their business because scientific and research instrumentation is phenomenon-dependent not project-dependent. And as long as somebody is willing to pay to have natural phenomena studied, there is work to do.

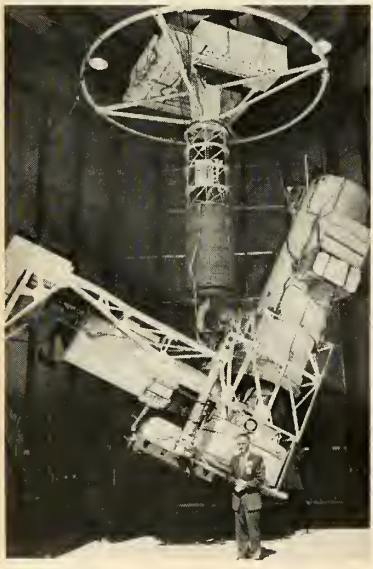
One of the most articulate spokesmen in the instrumentation field, Milton Greenberg, president of the Geophysics Corp. of America, sees vacuum technology as "one of the hottest technological fields going." Clearly, electro-optical systems destined for space intimately involve such technology both in the design of the systems and in their test.

The rate of growth of the field has been estimated to be greater than that of the electronics industry, with the present market estimated at "$70-80 million," according to Greenberg.

In the specific disciplines, astronomy is seen responsible for much of the activity in the electro-optical instrumentation field, particularly with regard to two current National Aeronautics and Space Administration programs. Bound up with the needs of astronomy is research on the electron image tube and in photographic analysis. Looking ahead, engineers are proposing lightweight optics structures that can be shot into space and pieced together there like a jigsaw puzzle, and NASA is currently considering the idea.

Re-entry phenomena are extending photographic technology even further in terms of microdensitometers for rapid readout and even reduction of data. Lasers are seen as contributing on a wholesale basis to meteorology and geophysics.

There is little cause for pessimism by manufacturers of missile/space instrumentation, according to Greenberg. He cites the rule-of-thumb for the cost of instrumentation on space vehicles;





LEFT: Three-ton Stratoscope II, giant balloon-borne telescope developed by Perkin-Elmer Corp. for Princeton University program, will again be sent aloft late this year on its first photographic flight. An earlier launch gathered infrared data. RIGHT: Infrared tubes, developed by Honeywell, are reported to be 10,000 times more responsive to infrared radiation than previous detectors. Designed to withstand conditions of extreme noise and vibration, these detectors will greatly expand military applications of infrared detection—such as nighttime mapping of terrain from the air and use of devices to locate enemy missiles.



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for example, about 70% of the total direct cost of the payloads.

• **Departure from orthodoxy**—Observation of the heavens through space telescopes will in a few years make obsolete nearly all the astronomical data so painstakingly gathered by astronomers ever since the telescope was invented. Anticipating this scientific revolution, many astronomers have left their observatories to experiment with electro-optical systems and space photography as a means for scanning the sky.

Two major astronomical programs stand out in this regard: *Stratoscope II* and the *Orbiting Astronomical Observatory* (*OAO*). The first calls for sending an unmanned telescope mounted in a plastic balloon to an altitude of about 80,000 ft.

Stratoscope II's first flight, in March, 1963, gathered infrared data on the atmosphere of Mars; another infrared study, in November, 1963, was directed at Jupiter, Saturn and certain cool red giant stars. The first photographic flight is scheduled for late this year.

The project, directed by Princeton University, was developed under the joint sponsorship of the National Science Foundation, Office of Naval Research and NASA. The 3-ton telescope was designed and built by Perkin-Elmer Corp., Norwalk, Conn.

The second major program, the *OAO,* calls for a 3,600-lb. spacecraft to be launched into a 500-mi. circular orbit by an *Atlas-Agena* in 1965. Four *OAO* launchings are scheduled at intervals of roughly 9 months and will include one or several of the following experiments: four 12-in. telescopes, which are being developed by the Smithsonian Institution to map the sky in ultraviolet; four 8-in. and one 16-in. telescopes being developed by the University of Wisconsin to study selected bright stars and nebulae; a 3-ft. Goddard Space Flight Center telescope for detailed studies of 5,000 stars and nebulae; and a 32-in. Princeton telescope for detailed studies of interstellar matter.

The overwhelming reasons for sending telescopes into space are to extend the wavelenth range, which for a ground-based telescope includes only visible light and short radio waves (gamma rays, X-rays, ultraviolet, infrared and long radio waves cannot get through the Earth's atmosphere) and to better the 0.3-arcsecond resolution of astronomical photographs taken from Earth.

If, for instance, the 36-in. telescope flown by *Stratoscope II* succeeds in getting its design resolution of 0.1 arcseconds and is able to maintain its tracking accuracy for hours at a time, then it will easily out-perform the 200-in. Hale telescope at Mt. Palomar.

• **Requirements for image tubes**—In space, "the electron image will have to do the job for astronomers that photography has done on Earth," Dr. Nancy Roman, NASA's astronomy chief, told M/R. She pointed out that space astronomy extends the requirements for such tubes to higher resolution—since the atmosphere no longer limits the resolving power of most astronomical instruments—and to a broader wavelength band.

"We are not interested in using image tubes throughout the region of the spectrum in which focusing optics can be obtained—that is, from a few hundred Angstroms in the ultraviolet down to tens of microns in the infrared," she said. "Ultimately, we should hope to use the image tubes to obtain measurements of close double stars, measurements of stellar parallaxes which involve the accurate measurement of shifts of star images of a thousandth of a second of arc relative to images within tens of minutes of arc, and other astrometric problems."

Miss Roman suggested that an important need in the meteorological program is "sufficient sensitivity (in image tubes) to provide pictures of cloud cover at night in the absence of moonlight and with sufficient dynamic range to provide not only day and night pictures with the same tube, but pictures of the cloud cover of the Earth at times when part of the picture is sunlit and part in total darkness."

For later periods in NASA's astronomical program, the agency is considering using lasers not only for tracking beacons but also for telemetry. "To accomplish this," said Miss Roman, "we must have an image tube with a fast response time, which can see 20th magnitude at night and 10-11th magnitude during the day and can track with an accuracy of better than one second."

• **Project Celescope**—The Smithsonian Institution experiment on *OAO,* known as Project Celescope, likely will be the most sophisticated electro-optical system yet placed in a satellite. The object of the experiment is to obtain high-resolution "television photographs" of the entire sky in four broad ultraviolet bands in the vacuum of space. The vacuum ultraviolet spectrum is particularly interesting to astronomers, but remains largely unknown because of atmospheric masking.

Among the techniques employed for the first time in a space environment will be digital television, a new ultraviolet television pickup tube, and the first practical space test of large precision optics.

Spaceborne equipment supplied for Celescope by Electro-Mechanical Research, Inc., Sarasota, Fla., will scan stars and nebulosities, transmitting video information to the ground in both analog and digital form. While the satellite is stabilized in space, four Schwarzchild telescopes will scan an area of the sky on four UVicon TV camera pickup tubes. These tubes are optically filtered to receive ultraviolet radiation from four different portions of the spectrum. Either analog or digital television scanning may be used as determined by commands initiated on the ground and transmitted to the spacecraft command decoder.

Exposure times ranging from 0.2 to 3.0 sec. are expected to be obtainable with the satellite stabilized.

On the ground, digital data processing equipment provided by EMR will automatically print out a star catalog of the 100,000 or more stars expected to be measured during the 12-month life of the satellite. This material is expected to provide astronomers with information concerning the composition of interstellar dust, the theory of hot-star atmospheres, the history of planetary nubulae and, possibly, the reasons for the hot outer atmospheres of cool stars.

• **Optical structures**—Lightweight optical structures, a giant beryllium mirror and a multimillion-fiber matrix of fiber optics are marking some of the technological advances that will have increasing application to space electro-optical systems. All these techniques are already incorporated in the telescope of a new Air Force ground-based optical surveillance system.

Intended for use in the Air Force program of detecting, tracking, identifying and cataloging all space vehicles, the Spacetrack system is being developed by the Electronic Systems Div. of the Air Force Systems Command. The optical portion of the subsystem is being built by Perkin-Elmer under a $1.5-million subcontract from the Radio Corp. of America.

The surveillance telescope, a modified Baker-Schmidt system, picks up the light energy and passes it through a corrector. From this point, the light strikes a 45-in.-dia. folding flat beryllium mirror. The light is returned to the primary mirror of an "eggcrate" fuzed quartz structure 44-in. in diameter, the largest lightweight optical component of its kind ever produced.

From the primary mirror, the light is brought to focus on a spherical image surface. Here, the light is picked up by fiber optics bundles where it is translated laterally for a distance of 20 in. to the input end of several image orthicon cameras. This combination makes it possible to electronically monitor the contiguous field of view observed by the telescope.

The cameras are designed to collect the information from each of the fiber optics bundles, and this is then "read" and stored by appropriate signal processing techniques. Readout and storage is completed within fractions of a second.

Looking five or more years ahead, Perkin-Elmer predicted to M/R the construction in space of 100-in. or larger diameter telescopes. The individual sections would be made of lightweight optics, but by positioning and joining them in space, they would be free of the stress applied by Earth's gravity. An interferometer technique would serve to sense the errors in misalignment of the pieces, and servos would make the appropriate corrections.

● **Advanced photography**—With the increasing use of photographic analyses in the defense and space efforts, the need has arisen for photographic data processing systems able quickly to reduce the vast amount of photographic data into meaningful information without sacrificing precision. The task has been, and will continue to be, for manufacturers of photographic analysis equipment to embody into their systems the most advanced electro-optical measuring instruments and data processing techniques.

"The market for such systems could approach $15 million by 1970 as their use grows in photographic analysis associated with missile and space programs, re-entry studies, photo-reconnaissance and astronomy," estimates Burton W. Wheeler, Jr., general manager, David W. Mann Co., a Lincoln, Mass., division of Geophysics Corp. of America.

Re-entry studies in particular provide a current example of the system requirements. To satisfy some of them, digitized microdensitometers have been developed by the Mann Co. for use in optical studies of ballistic missile re-entry flight tests.

These systems measure position in two coordinates and optical density of micron-sized images while scanning photographic plates at rates up to 625 mm/min. Even at this maximum scanning speed, position accuracy is one part in 100,000, optical resolution is better than two microns, and measurement of relative lightness or darkness of images (optical density) is provided up to densities as high as 5.0. High-speed digital readout on Air Force and Lincoln Laboratory instruments is provided on magnetic tape.

Other companies are also well into the microdensitometer field, including Ansco, Binghampton, N.Y. This company's system is completely automated and can be used for such tasks as lunar mapping, planetary mapping, satellite tracking and for nearly any other work requiring rapid and accurate measurement of optical density as a function of spatial distribution.

● **High-speed photography**—With the need to study physical phenomena down to as much detail as possible, "there is a trend toward high-speed photo-instruments that will simultaneously record both streak and framing records of an event from the same optical axis and on the same time base," says Myron Baldwin, vice president, Beckman & Whitley, Inc., San Carlos, Calif.

The streak record provides highly accurate time resolution of the event and the framing record provides complementary spatial and qualitative information. By correlating these records, the scientist can analyze and interpret many events much more quickly and accurately than he could from either record alone.

"Another trend has been a pronounced increase in the use of Polaroid film in research cameras and this trend will continue," says Baldwin.

Noting that until recently, ultra-high-speed, time-resolved spectrographs have been used in only a few advanced laboratories, he observed "there appears a trend toward use of this type of instrumentation on a much wider scale in the study of non-equilibrium events, particularly plasmas." He expects that in the near future, "high-speed, time-resolved spectrographs will also be used in space exploration."

● **Geophysical needs**—In the period directly ahead, techniques will probably be developed for deducing the vertical variation of atmospheric temperature, composition and other atmospheric structure parameters from an orbiting weather satellite. Up to now, most of the data returned by the *Tiros* satellites have been in the form of pictures of cloud cover. These have been useful, but to really improve modern weather forecasting techniques, which use electronic computers, one needs information on the actual structure of the atmosphere as input data.

In view of this, "observations of infrared radiation from the Earth and its atmosphere made by an instrument onboard a satellite could serve as the basis for providing this input data over the large regions of the world without weather observations," suggests Dr. George Ohring, manager of Geophysics Corp. of America's meteorological physics department. Here, the scientist parellels Nancy Roman's quest for highly sensitive and versatile electronic image tubes able to work in a radiation spectrum that includes the infrared.

Many novel techniques are being developed for making important atmospheric and geophysical measurements. Some of these include the use of lasers for measuring atmosphere density up to 100 kilometers; the measurement of minor constituencies by virtue of either resonance radiation, absorption or Raman emission. "These developments will make use of the ability to select frequencies by means of such non-linear phenomenon as harmonics and Raman emission," advises Jerome Pressman, GCA's manager of special projects department.

He sees lasers used for measuring clouds of particulate material in the atmosphere. This particulate material may be due to meteorite re-entry or to clouds of particulate matter deposited by missile trails, re-entering space vehicles and such.

Pressmen suggests that additional geophysical variables, such as temperature, may be measured by the differentiation of the density profiles obtained, while the possibility of measuring atmospheric temperature from direct Doppler shift still remains to be proved. "There is the possibility that winds may be detected through Doppler shifts," he notes.

Despite the injection of lasers into some of the advanced geophysical instruments, preferred room is still given to simple ground-based systems of conventional components if they are able to do the job. Here's a recent example of such a system, which uses a simple carbon-arc searchlight to probe the structure of the upper atmosphere:

Designed by Measurement Systems, Inc., South Norwalk, Conn., the projector-collector system was developed under an Air Force contract to permit the measurement of atmospheric light scattering at altitudes up to 60 km. The projector and collector are located at Sacramento Peak and Twin Butte Mountains, N.M., respectively.

An interesting anomoly was found. There was a dust layer always present in the atmosphere at an altitude of about 57,000 ft. When the wind is blowing dust into the valley, the layers of dust can be detected as high as 30,000 to 40,000 ft. These phenomena are, of course, invisible to the eye and difficult to detect by attenuation or transmission instruments.

The projector, the Navy searchlight, is aimed upward at an angle of 75 degrees. The collector, located 20 mi. away, consists of a radiometer—actually made from a second Navy searchlight —which can be made to scan up and down the returned projector beam. The system records the intensity of the light scattered from the projector beam at various altitudes. To make the system as insensitive as possible to extraneous light sources such as stars, scattered city lights and moonlight, it was designed for synchronous demodulation. ■

Surveillance Promises Civil Spin-Off

Research directed to military needs also holds great peaceful potential; multi-sensor 'utility' satellite under consideration

VISIBLE AND INFRARED image processing and transmission represents one of the fastest growing technologies in electro-optics. While the constant military requirement for better surveillance systems has given impetus to much of the research in this field, the high-resolution narrow-bandwidth systems that the military requires also have a large potential commercial market.

Xerox has already announced its interest in picture transmission and a group of experts in this field has assembled in its research subsidiary, Electro-Optical Systems, Inc. Other military fallout occurs in infrared systems. A company such as Infrared Industries, Inc., very active in developing sensors for surveillance systems, is also busily developing infrared scanners for medical and industrial purposes.

The general feeling in this whole field is one of promise. Researchers point to lack of expenditure on optics in the past compared with expenditure on electronics, and suspect that many new devices and materials will appear in the future.

At the same time the increasing quantities of pictorial material on file indicate a growing requirement for automatic data processing equipment that can rapidly retrieve significant information.

Fairly soon the Air Force will have to decide whether it requires a family of surveillance vehicles or one common spacecraft that can carry out various forms of ground mapping or satellite inspection. Furthermore, as the areas to be surveyed and the types of orbits used for surveillance increase, particularly in regard to satellite inspection, increasing requirements will appear for ground transmission of video information. This will be an additional spur for the development, say, of a system with 2,000 line resolution and an output that can be carried over a commercial telephone circuit—highly desirable for business use.

The first use for a maneuverable satellite that can change its orbital plane is likely to be for reconnaissance, and while development of a vehicle of this type is some time off, integrated systems being planned now must take it into consideration.

● **Utility satellite**—One proposal that is heard in industry is for a multi-sensor surveillance satellite operated for geological survey work (domes and anticlines representing potential oil-bearing areas can be detected), forestry and agricultural research (forest mapping and detection of disease), topographical mapping, icepack and iceberg monitoring, snow and ice detection, weather observations, and mapping of near-surface ocean currents.

A system of this type has been discussed at the western operation of Sylvania Electronic Systems as a device that would also be used to monitor arms control. The company is under contract to the U.S. Arms Control and Disarmament agency to study verification methods associated with the prohibition of placing mass-destruction weapons in orbit and limitations on conventional military activities.

Present Air Force surveillance operations in space concentrate on making the best of a poor situation. Photographs from 100 miles, taken through the entire atmosphere, are inevitably much lower in resolution than those that can be taken by aircraft. Cloud cover can obscure 50% of the Earth's surface under good conditions. Times of potential surveillance of satellites can be predicted in advance. Pictures have to be taken in daylight. Data retrieval is difficult. And the whole operation is extremely expensive.

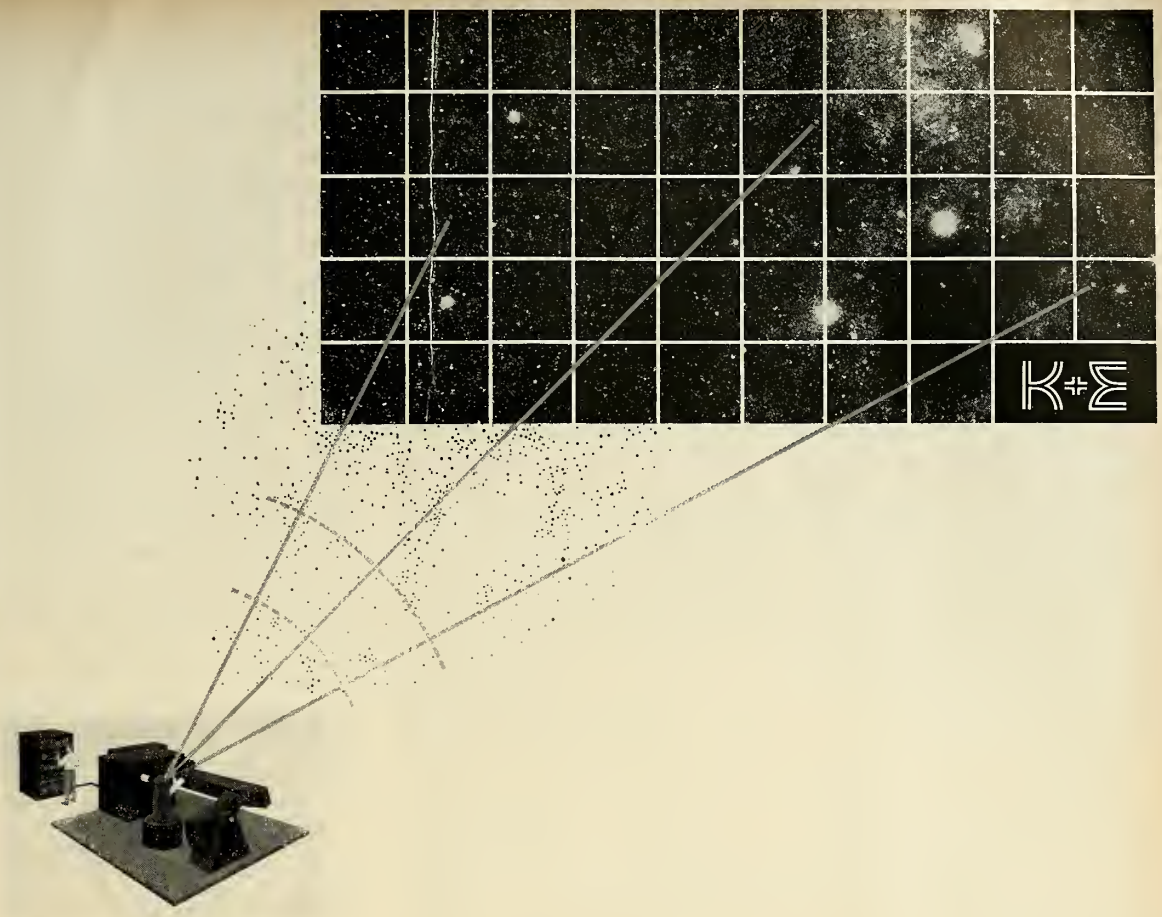
● **Limitations of space photography**—To meet the special requirement of detecting ballistic missiles in their launch phase, satellites with infrared detectors do provide something approaching a tactical capability. But the continuing programs for measurement of target and background infrared signatures suggest that the situation here is still not entirely satisfactory.

As far as optical surveillance is concerned, the information obtained is chiefly suitable for charting and mapping target areas rather than finding out what is happening there.

Unfortunately water vapor, smoke, dust, or other aerosols obscure industrial areas—the areas of greatest interest. Astronaut Gordon Cooper could not see cities such as San Diego or Calcutta when he flew over them. The only areas consistently clear throughout all *Mercury* orbital flights were the western African desert and the southwestern United States. And in the second of these areas, White Sands Missile Range reports that average atmospheric conditions limit the resolution of their instruments to 20 lines/mm. So even the most consistently visible areas have an atmosphere above them that restricts satellite photography to that obtainable with a relatively simple lens.

Another indication of the limitations of space photography is seen in the deviations of light rays due to turbulence. These vary across the Earth's surface from an average of three seconds of arc in New Mexico to 10 to 20 seconds of arc over areas with less stable atmospheric characteristics. Fifteen seconds of arc corresponds to a ground distance of 45 ft. when looking down 100 nautical miles. If resolution is limited to this value even perfect optics will fail to detect military vehicles.

In practice this resolution will usually be degraded still further by other scattering processes.



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On the other hand, there are brief periods of high visibility, when the atmosphere has been washed clean, when much better pictures can be achieved. Then high-performance military cameras are variously reported to be capable of identifying objects of between 120 ft. and 30 ft. at 100 nautical miles. Also ribbon features, such as roads or geological faults, can be recognized even though they are not theoretically resolvable.

Infrared film can improve visibility through haze, but it presents aggravated problems of exposure time and image motion. Infrared can also penetrate clouds to a greater distance than visible light, but not far enough.

The low effort that the Air Force has put into systems for looking at satellites from the ground, in contrast to its work on fly-by inspection, shows how difficult it is to obtain pictures, through the atmosphere, of objects with dimensions of the order of 10 feet.

The resolutions quoted for the optical systems are for high contrast objects, whereas military targets are of low contrast. Satellite surveillance systems will not detect land mines, give reliable vehicle counts, or show whether bombs have cut railroad tracks.

● **TV may be answer**—The result of this situation is that increased impetus has been given to the development of television systems, since they promise to give as much resolution as the atmosphere permits and can also be used for other missions such as satellite inspection, where capsule recovery requirements must not restrict the vehicle orbital plane.

Wright-Patterson AFB is funding the development of a 3,000-line television pick-up tube, and a 5,000-line image-dissector tube is also under development. One of the most pressing problems with such systems is that if real-time readout is essential, the signal bandwidth is more than available space-qualified transmitters can handle. Even a 2,000-line system, considered feasible now, will require about 20-mc. bandwidth. Fortunately picture storage and slow-scan readout can be tolerated in many missions. Use of an insulating layer on the photoconductive surface of vidicon provides a tube of this type—as used in *Tiros* Automatic Picture Transmission (APT).

Other forms of low-speed readout are also becoming available. Ampex has demonstrated that a video recording on magnetic tape can be successfully played back at one-tenth record speed. Thermoplastic and electrostatic storage tapes have also been developed.

A great deal of research is being carried out on sensors. Vidicons and related devices with an IR capability are beginning to appear as production items, and solid-state mosaic detectors are in the research prototype stage. For ultraviolet, some imaging devices are beginning to appear, but as yet the region is largely unexploited.

There is a feeling in some parts of industry that production of special camera tubes is an area where small firms can compete with the giants of the electronics industry.

● **Seeing eye vidicon**—A vidicon that can tolerate the extremes in light level between the night and day sides of the Earth, without adjustment, has recently been developed by Westinghouse. Called the SEC-Vidicon, it can virtually see in the dark but shows no blackout from sudden bright light. Light falling on a photo-sensitive cathode releases electrons that accelerate into a thin porous film and generate a large number of secondary electrons. Applied electric fields sweep out the secondaries, leaving an amplified charge image. This can be read out by a scanning electron beam to within a few percent in one frame. Ultimate resolution is expected to be about 3,500 TV lines per inch.

The sensitivity of this tube is comparable to that of an image orthicon. But it does not require the added complexity of return beam readout. The picture is inherently free from beam shot noise and halation is greatly reduced.

A solid-state image-storage device has been developed at Molectro Corp., using polarization in a ferroelectric as the storage process. A ferroelectric single crystal has been electroded with storage elements on 0.004-in. centers and yielded an image point density corresponding to 10 lines/mm. Doped thin-film cadmium sulfide is used as the light-sensitive material on the image side of the unit. When light falls on this, the current that flows polarizes the dielectric. Readout is by a light beam, scanning the other side of the storage device. This yields a current flow to the device electrodes that is the analogue of the stored image.

Advantages cited for the device are high signal output, a potentially wide range of spectral responses (extending into the near-infrared), and long storage time.

● **Facsimile systems may fill gap**—As an interim between a full television capability and present use of film, facsimile systems involving flying-spot scanning of film will come into increasing use. They provide the high resolution of film with the quick transmission time of television. If a reusable film could be developed for use with these devices they could find extensive use in satellites, because they are already proving reliable in field tests carried out in aircraft.

The systems may also be used for taking a quick look at film exposed in orbit, prior to, and as a back up for, capsule recovery of the film. Today, flying-spot scanner systems are the only ones available to get high-resolution picture information back over a radio link.

The Photoscan system produced by CBS Laboratories was shown in recent Navy tests to be highly suitable for average resolution (20-40 lines/mm), medium to large-scale reconnaissance photos. Tests were carried out with a 10-watt, 2,250-mc data link with 6-mc bandwidth. One of the biggest difficulties was getting enough power from the airborne transmitter. Acceptable transmission was obtained over 50 miles "under the most adverse conditions." Scanner development was considered in advance of other components in the system.

Heart of the system is CBS Labs' rotating anode Line Scan Tube, in which scanning spot size has been reduced to less than 1 mil over a 4.5-in. line. This means the tube could be considered to have better than 6,500-line resolution.

A scanning system that requires no intermediate processing has been developed by Measurement Systems, Inc. The unit has a 140-degree field of view along its scan line, achieved with a mirror rotating at 7,500 rpm. Area coverage is gained by moving or rotating the camera.

Weighing 8¾ lbs., the unit is extremely compact. It can provide 1,500 TV line resolution at 500 lines per second. One million picture elements are generated per second.

A system of this type was developed by the Aeronutronic Div. of Philco Corporation for surveying the Moon from a hard-landing *Ranger* and is very suitable where image motion—or lack of it—makes the long frame time acceptable. But target motion often requires use of a shutter to immobilize the image, in which case a film has to be exposed and subsequently scanned —as in the *Lunar Orbiter*.

● **Flying darkrooms**—To meet a long-standing AF requirement that negative film should be processed in flight, Eastman Kodak Company has developed a process based on diffusion-transfer principles, in which the solution-containment problem is said to have been eliminated. Called "Bimat," the process also has the advantage that a positive image is obtained at the same time as the negative. The negative can either be discarded or further processed. Keeping time of the film is 1 to 2 weeks at room temperature or a month at refrigerator temperatures.

Another saturated wet or mat process available is that developed by Fairchild Space and Defense Systems. This is PoroMat, which employs a plastic material with a processing solution.

In situations where low exposure levels are the rule, image orthicons have offered a possible solution for some time, and there is an indication that the Air Force is taking increasing interest in systems of this type. The 48-in.-dia. telescope nearing completion at Cloudcroft, N.M., will use an image orthicon as its detector. If the system is intended to explore the possibility of taking pictures of satellites, it will have a focal length of thousands of inches. An image orthicon can operate with an f/100 lens system, so that the Cloudcroft instrument could have a focal length of 5,000 in. and still yield a high data rate. (Mirrors with focal lengths of hundreds of miles have been ground, but for other applications.)

The main disadvantages of image orthicons for space use are lack of a flight rating, their lack of resolution, and the increased amount of supporting equipment they need, compared with vidicons.

● **Tracking and discrimination**—A study at Douglas showed that large astronomical telescopes of the Mount Wilson type could be used to study satellites in orbits of 70,000 miles. Low-orbit satellites call for more rapid tracking than astronomical instruments are capable of.

For detection of one orbiting vehicle from another, far infrared is often suggested. There is a certain amount of work funded by the Air Force on liquid-helium cooled detectors that rely on a magnetic field effect for detection of infrared radiation out to 1,000 microns.

Present lenses used for satellite reconnaissance missions are probably in the 48-in. focal length, f/4 class, with electronic shutter triggering and film advance. Greater focal lengths would require improved satellite stabilization.

● **Lens design**—The field of lens design is very active. J. W. Fecker division of American Optical Company has recently produced solid Schmidt Systems with an f ratio of less than 0.4 and aperture larger than 14 inches. These lenses have fields of over 30 degrees. Other lenses have been optimized for the response to moonlight on an S20 photocathode. The division is currently being expanded to handle mirrors up to 120 in. in diameter.

A compact long-focal-length telescopic lens is being built by Northrop Nortronics, using two aspheric mirrors. Calculations show that it will cover 25 times more area than a Cassegrain system and 2.8 times more than a Ritchey-Chrétien system. Nortronics is also expanding work on a technique that may allow certain types of instruments to operate beyond diffraction limits.

Possible increase of resolution by use of fiber optics techniques is also being given consideration.

● **Help for interpreter**—The increasing competence of surveillance systems to give pictorial data is leading to a demand for systems to pre-digest this information to relieve the strain on human operators. Marquardt Corp. has conducted studies on categorization of scenes by geometry, spectral distribution, and luminance characteristics. Philco's Aeronutronic Div. is working on an automatic system for identifying inhabitated areas by counting right-angle intersections, and intends to investigate the scope of this class of techniques by use of an optical image computer.

The type of installation that will be increasingly required in the future is exemplified by the Image Interpretation Cell being procured from Fairchild Camera and Instrument Corp. by the Air Force's Rome Air Development Center. This $7-million contract is intended to speed up processing and interpreting of photographs taken by reconnaissance aircraft in a tactical warfare situation. The cell is air-transportable and equipment includes an AN/UYK-1 digital computer and a multisensor viewer capable of accepting four separate film rolls.

Fairchild has also developed a high-resolution data reduction system to convert photographic information of varying formats into a single standard size.

Functions such as these will become increasingly important to military satellite surveillance as the inventory of photographs builds up, especially when a search has to be made back through the files to discover the trends leading up to a sudden change.

Use of mosaics to detect change automatically has been suggested by J. R. Shepard of GIMRADA, U.S. Army.

A data storage system that can record video direct from satellite TV cameras and subsequently read the signal out at slow speed has been developed by the Link division, General Precision, Inc. Photographic film (35mm) is used as the storage medium, at a data storage density of 700,000 bits per square inch. A read/write data bandwidth of 10 mc is said to be attainable.

Sperry Gyroscope has suggested that fiber optics devices of the Sceptron type could be used for automatic photo analysis.

A comprehensive photographic system for producing geodetic and cartographic data, AN/USQ-28, is being developed by Kollsman Instrument Corp., and several innovations in the system are being investigated for potential applications to lunar and space mapping.

Developed in the system are precise positional data for each exposed frame's photo nadir point from a high-performance inertial navigator. A photographic record of verticality, accurate to 30 arc seconds, is obtained on each mapping frame. Terrain profile data are obtained by radar, but in a satellite system the function might be obtained by a laser ranger.

Lasers as illuminants for surveillance photography seem a long way off due to non-linear effects and interference phenomena in the coherent beam. First application of lasers to surveillance being pursued by the Air Force is a radar-mapping type of device.

● **Infrared**—Prime activity in infrared space surveillance has been the detection of missiles in the boost phase. That is, the systems have been concerned with spectral discrimination rather than imaging.

Prime contractor for the Program 239A vehicle used for this work has been Lockheed, with Aerojet-General providing some of the sensors. Both companies are in fact active in the IR sensor field.

The technique used in these satellites would appear to be to detect emissions in the 2.7-micron region—the carbon dioxide absorption band. Previously the systems attempted to operate through one of the IR "windows" in the atmosphere and ran into difficulties of target discrimination. In the absorption band, however, only extremely intense emissions can penetrate the atmosphere, so that the background is automatically eliminated. As the missile climbs up through the atmosphere, the attenuation of its 2.7-micron emission decreases and it becomes increasingly easy to detect.

Further confirmation that it is a missile emission that is being detected is obtained by use of a diffraction grating to select two or three bands of about 0.40 microns width to provide a check on a spectral distribution of the emitted radiation. Lead-sulfide detectors are used.

A lot of work has gone into the development of large light-weight telescope mirrors for IR work, including the production of beryllium mirror blanks. One type of system that can be used for searching for IR targets is a spherical primary mirror with a nodding Newtonian folding mirror. This covers fields of 5 degrees quite easily and can be used to watch predetermined launch sites. However, if the point of launch is not known, a much wider angle of scan is required.

For this reason the vehicle is likely to carry a coarse scanning system for the rapid detection of targets, and a fine scanning system that is directed to targets after they are detected. For this latter system Lockheed is aiming for a pointing accuracy of the order of 20 arc seconds.

The ultimate accuracy of the system depends on use of a very stable time base within the satellite and on an ac-

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curate knowledge of the satellite's trajectory. The indications are that surveillance satellites of this type are providing an accurate inventory of the progress of Soviet space shots. Explosion of a large booster, for example, should be quite easy to detect.

● **New trend in scanners**—A development expected in the near future is a move away from mechanical scanning systems to use of mosaics of lead sulfide cells. Infrared Industries claims to have the capability of producing mosaics with packing densities of 2,000 per inch. The aim is to couple these with arrays of integrated amplifiers and electronic multiplers. Principal problem at present lies in obtaining reliable interconnections to the mosaic.

These devices will also be suitable for use in infrared imaging applications. Other companies active in this field are Hughes, Aerojet-General, and Lockheed. Hughes suggests that systems with 100 detection channels served by individual amplifiers are quite conceivable in a total volume of 2 cu. in.

In imaging tubes, PTW in Germany has produced one that operates out to 4 microns; a two-micron vidicon has been produced in England, and RCA has operated cooled vidicons at longer wavelengths. A Japanese tube works out to 2.4 microns and can be operated in an ordinary television camera. Other tubes are being developed under classified projects.

Infrared is a rapidly growing area of industrial activity. For example, over the past year, Sperry Gyroscope Company has broadened its activities into such areas as IR imaging and real-time IR tracking and ranging. The company's interests include space-to-space reconnaissance and multiple target surveillance of IR point targets. Texas Instruments claims an interest in virtually every phase of infrared systems, including relatively large optical systems, arrays of cryogenic long-wave detectors, and signal-processing devices for maximum information yield. The company feels that the problems in these areas are technological rather than physically basic, and appraises the future for advanced reconnaissance with considerable optimism.

One result of this growth of IR activity is an increased demand for IR calibrating instruments and systems. A large collimator system developed by Infrared Industries, in the PACE 1000 series, interfaces with a GE 225 digital computer to give a unique automatic checkout device for satellite payloads. A three-inch cavity black-body source injects radiation into a folded-path mirror system that can direct an accurate beam into a satellite payload carried on a massive machine table, adjustable in three degrees of freedom. ■

Circle No. 24 on Subscriber Service Card

Metrology Developing Rapidly in Face Of Challenges of Missile/Space Work

Stress is on ever-greater accuracy and automation; many firms boast excellent labs; adequate verification methods lacking

THE EXPLOSION in electro-optical metrology detonated by complex missile and space programs is creating automatic equipment with almost fantastic accuracies and incredible precision.

Even so, many industry observers believe that metrology is still far short of realizing its full potential.

For instance, J. E. Brogan, director of industrial sales for Kollmorgen Corp. and a former optics design engineer, says the basic lack confronting the field today—aside from insufficient time and money—is a ready means to verify and certify the readings of hyper-accurate measuring instruments.

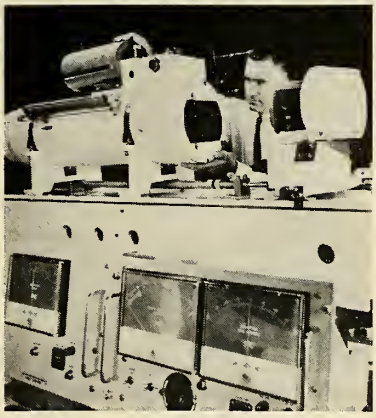
The rule of thumb at the National Bureau of Standards is that it should be able to measure ten times more accurately than the level it will certify. This means the NBS has to absolutely measure to ±0.10 sec. of arc to certify ±1 sec. of arc.

Brogan says the problem of how the instrument producer checks the instruments vis-à-vis the way their customers check them comes up again and again. In general, certification is expected to be traceable within at most three generations to NBS.

This is a criterion acceptable to just about everyone, says Brogan, and this is true especially in the machine tool field, where in-house metrology labs do not exist. A written assurance is demanded.

But Brogan also cites Kollmorgen's experience with firms within the aerospace industry, where the opposite is true. These companies have excellent metrology labs and can do their own checking. They rarely demand certification from the vendor.

Furthermore, these firms may be participating in the Navy's Standards Laboratory Information Manual (SLIM) programs, which give them free access to primary standards labs. Kollmorgen itself, as prime contractor on various Navy contracts for *Polaris* submarine star-tracking periscopes, has used this service.



ALIGNMENT theodolite system developed by Perkin-Elmer for Saturn V launch azimuth alignment can operate at distances of 300-1,000 ft. and angles of 20-40 degrees. Major problem with such devices is atmospheric effect on light transmission. Compounding this is the sway and twisting motion of the huge Saturn—both loaded and unloaded. P-E developed a deviation-reducing prism for launch use. The atmospheric limiting factor in this type of equipment is present in all electro-optical devices. For this reason, a number of bench instruments are being built in vacuum chambers.

Brogan cites certain limitations in this area—primarily a need to guarantee to a customer angle measurements which exceed those available from the Bureau of Standards. The Bureau can certify measurements to 0.2 arc secs.

In such cases, Kollmorgen—like most firms faced with the same problem—goes back to fundamentals and uses a self-checking instrument such as the theodolite, where the only requirement is that the scale closes or is continuous and that there are no uncontrollable biases in the system.

This statistical approach is tedious, but Brogan says it is the only route to such measurements. It satisfies the customer because it is based on standard engineering procedures and can be readily demonstrated.

Brogan is convinced that the future of this type of metrology equipment lies in the direction of and beyond such electro-optical devices as the completely automatic autocollimator. The needs of the industry point to sophisticated automated equipment which can be run by relatively unskilled personnel.

Brogan says the instrument Kollmorgen will bring out to supplement the existing line of equipment will differ considerably from current automatic autocollimators.

The unit has to function much more swiftly than those on the market today, says Brogan, and must follow a dynamic system—giving answers almost instantly. "This will be an instrument that can be used in industry as a transducer for complete automation. In the areospace industry this will get the man out of the loop and thus give greater accuracy and long-term stability."

Besides the obvious problem with a man in the loop, there are measuring applications in hostile environments—where automatic operation is a must.

Optical metrology work is also concerned with extremely precise linear measurements; Brogan points to linear accelerators as one example.

Linear accelerators now being constructed are nearly 2,000 ft. long, and the alignment between the center lines at each end must be within ±0.0001 in. Brogan says it is possible to get readings with this sensitivity by using diffraction-type devices. Over such a distance, however, the supporting structure would not maintain that alignment unless the accelerator tubes were constantly servoed into alignment.

Here again, says Brogan, the trend is to a new generation of optical alignment equipment which must succeed the classical optical imaging devices. These depend on lever arms and mechanical micrometers for accuracy.

The new generation of devices includes diffraction units, based on Young's classical experiment. A whole new line of optical metrology devices will eventually develop from this principle.

• **Fundamentals**—Although the field is advancing with great rapidity, the basic objectives have not changed since the first rudimentary ruler. Electro-optical metrology is concerned with the measurement of angles and distances —and all possible applications fall into four clasifications: angles to the body, distance to the body, orientation of the body in rotation about the line of sight, and tilt of the body with respect to the line of sight.

All optical metrological measurement is based on five fundamental techniques—all of which follow directly from the metrologically useful properties of light, such as straight-line travel, short wavelengths, known velocity and ability to polarize.

These five techniques include alignment, transit time evaluation, standing wave evaluation or interferometry, autocollimation and polarimetry.

Alignment instruments are the oldest optical devices; they include ranging telescopes, alignment telescopes, navigation instruments, star trackers and triangulation rangefinders. Transit-time ranging devices are much less common and are primarily employed in military applications and special surveying work. Since the speed of light is the basic measuring element, this type of instrument is not feasible for short ground measurements—and the long-distance use is limited by backscattering problems.

But the technique will see more applications in space, where there is essentially no backscattering. The advantage over conventional radar methods is the small size of the equipment needed to obtain a narrow beam spread.

The optical maser, or laser, will be a boon to this technique because of the high brightness, narrow beam spread and continuous pulsing ability.

Interferometry makes use of the short length of light waves. In an interferometer, light of one wavelength—monochromatic—is divided into two parts, one going to a reference mirror and the other to a mirror presumed to be on a target.

The reflected beams are recombined in the observer's field and, if the difference in the distances to the two mirrors is a whole number of wavelengths, the in-phase beams reinforce each other and appear bright. If the difference is a whole number plus a half wavelength, the out-of-phase beams cancel each other and the field appears dark.

Since the field will complete a full cycle from bright to dark if the target mirror is moved by one wavelength, the high precision of this measuring technique is obvious.

• **Laser inputs**—There are techniques which allow a direct determination of distance by interferometry without counting waves. These techniques involve the use of several different wavelengths of light.

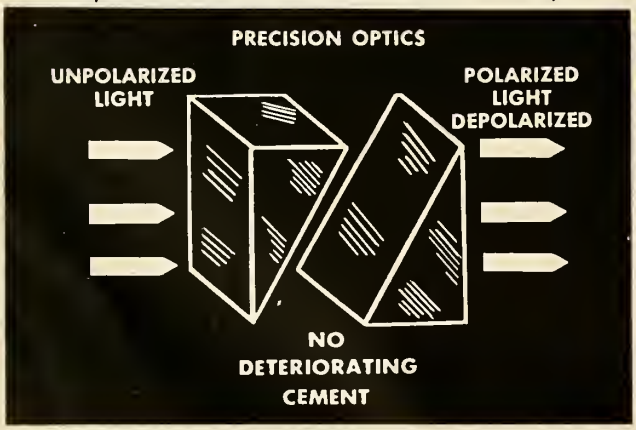
The laser has a particular application here. The extreme longitudinal coherence of a gas laser means that reasonably constant phase conditions can be maintained for large differences of path length. Earl J. McCartney of the Electro-Optics Group, Sperry Gyroscope Co., says this makes long-path-interferometry possible—where distances of several hundred feet can be measured to accuracies of a few microinches.

The Bureau of Standards used a gas

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laser in a Michelson interferometer and obtained interference fringes over an optical path of about 200 meters. The significance is obvious when one remembers that conventional light sources limit interferometers to paths of less than 2 meters.

In addition, experiments at Sperry Gyroscope using a laser in a Michelson interferometer have shown that velocities of 0.001 in./sec. can be measured reliably. The theoretical lower limit is several orders of magnitude less, and the practical limit depends on the frequency stability of the laser.

Non-contacting measurement of linear velocity with a fast response to velocity changes is suggested by the laser's ability to perform optical heterodyning and to measure the Doppler shift of frequency.

Sperry experts have demonstrated that a monochromatic gas laser operating in a special resonant cavity can measure angular velocity (see Guidance and Navigation, p. 37) with respect to an inertial frame of reference. While the inertial sensing of rotation may appear to be in the province of inertial navigation, McCartney says, meeting the demands of the technology may result in the application of ring laser principles in metrology.

● **Polarimetry**—This technique, based on the polarization of light, permits the measurement of twist angles. The precision is wholly independent of optical image quality and is based only on the quality of the plane-polarized light.

Polarimetry has been used for years in chemistry and physics and, in the case of the visual polarimeter, the accuracy is limited to about 100 arc secs. Automatic instruments reach accuracies better than 1 arc sec.

● **Autocollimation**—Instruments based on the technique of autocollimation are used more today than are those of all other electro-optical techniques combined. Interest has been and is extremely high because of the remarkable precision obtained from relatively simple active angle-measuring devices.

In a visual autocollimator, the light from an illuminated line reticle is projected by the objective lens to a target mirror. The reticle is focused at infinity, or collimated.

Light re-entering the objective from a mirror located at any distance will be autocollimated—focused into a sharp reticle image in the reticle plane. If the mirror is precisely perpendicular to the autocollimator axis—which is defined as a line through the center of the reticle pattern and the lens—the reticle image will fall exactly on the reticle.

Otherwise, the reticle and its image will be observably separated.

Autocollimation precision is such that a simple device such as the Watts autocollimator can detect mirror deviation of less than 0.2 arc secs.—an angle produced by a 1-microinch movement of the edge of a 1-in. mirror.

For really high performance, an automatic autocollimator is necessary. Theory and experiment have long since demonstrated that an accuracy of better than 1/10,000 arc sec. is obtainable. This is an angle which corresponds to 6 in. at the Moon or a 0.5 billionth of an inch movement on the edge of a 1-in. mirror.

Engineers at Perkin-Elmer have replaced the flat mirror by two mirrors with a 90° angle between the reflecting faces. If the reflector is suitably aligned, with its apex parallel to the reticle line, the line's autocollimated image will be superimposed on itself. If the dual mirror system is rotated about the line-of-sight, the autocollimated line will rotate through twice the reflector rotation angle. Such an instrument is called a twist autocollimator.

If it is made automatic, its accuracy is better than 1 arc sec.

● **Automatic everything**—The undeniable trend in metrology is in the direction of fully automated devices. This is generally recognized by instrument firms, their industrial customers and government agencies.

In fact, none of the significant advances in metrology would have been possible without automatic instruments. Performance gains in excess of 10,000 times are attainable and have been demonstrated.

The superiority of automatic instruments is based on the use of photodetectors and the electronic processing which can be applied to their output signals.

Dr. Adolph Razdow, president and director of engineering at Razdow Laboratories—developers of the MIDARM (Micro Dynamic Angle & Rate Monitoring System)—says fully automatic precision test devices free highly skilled engineers from the tedious measurement functions. This lets the user concentrate on advancing the state of the art in the technology represented by the particular device being measured.

Razdow says the metrology of the future will, in one sense, be very much like that of today: the customer will have to be educated to higher performance and accuracies. Beyond this the planner will have to learn even faster to advance his art—and here the answer is automatic metrology systems with increasing accuracies.

For example, Razdow says most firms are interested in instrumentation which provides complete information on the test object as soon as possible without having a skilled engineer involved in calculations or interpreting.

● **Midex**—The Razdow Labs have developed a number of highly sophisticated instruments capable of doing exactly this and at extreme accuracies—but for a price. One such instrument is the firm's Midex Indexing System.

This is a precise positioning head with automatic readout and display. It can be used for calibration, acceptance testing, performance evaluation and check-out, and as a positioning and holding fixture.

The rotating portion of the unit contains two movements—an index head consisting of a pair of precise self-centering crown gears having 360 teeth, and a vernier which is a tangent screw similar to the manual screw on a theodolite.

The index provides 360 discrete positions at 1° ± 0.25 arc-sec. intervals. The vernier provides continuous positioning between the discrete points.

The tangent screw provides positioning over any one-degree interval, with sufficient sensitivity to position the head to within 0.1 arc-sec. This motion is sensed by a Razdow MIDARM Mark XIV Optical Unit; the two-phase analog output drives the tracking servo module to activate the up-down display of the counter with 0.1 arc-sec. resolution.

The Midex system displays the actual error of the test specimen in seconds of arc with an accuracy independent of eccentricity and play. The unit is self-locking for positioning purposes.

● **Accuracy growing**—Razdow says there are several compelling reasons for higher accuracies. For instance, in terms of angular standards and requirements, the rate accelerations required today are of the order of 0.001°/hour. If the instrument has an accuracy of 0.05 secs. of arc and a range of 1 degree, the test will take one minute. Higher accuracies, then, have a significant effect on the test time.

If accuracies force tests such as those connected with gyro drift rates to long test-time periods, any number of things may provide unwanted inputs. A short time-to-answer cuts this down.

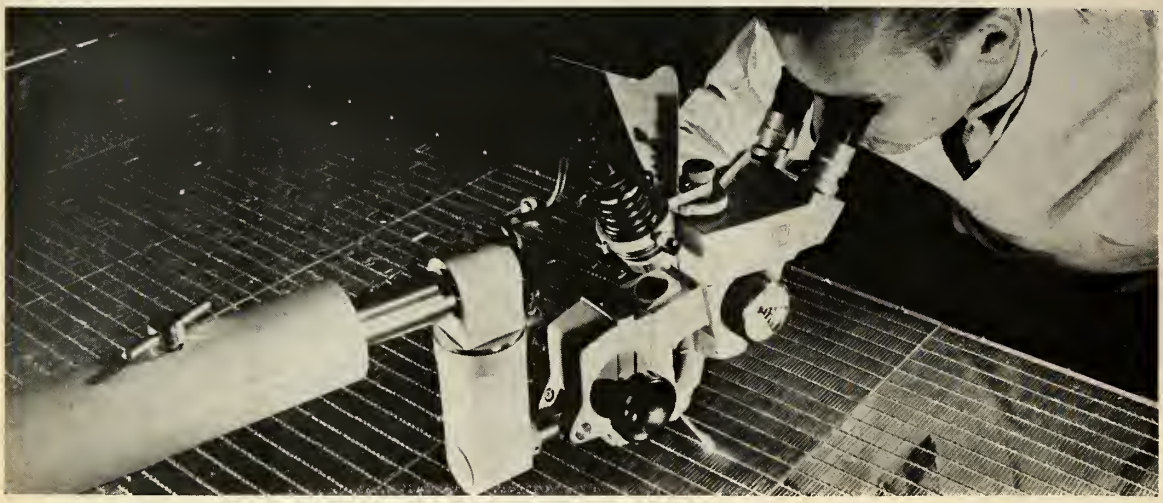
In any case, the accuracy of the test instrument must always be at least an order of magnitude better than the item under test. Trends in requirements here point to angular encoders and resolvers with accuracies of one sec. of arc. Interferometer devices will soon measure down to a few thousandths of an arc-sec. All of these will be under rigidly controlled conditions.

Razdow believes that in ten years the tough requirements of military and space planners will become part of the everyday curriculum of industry. Some of the sophisticated equipment now performing in laboratories will become part of manufacturing. In fact, this process has already begun. ■

ELECTRO-
OPTICS

Solar Cells Continue in Lead as Most Reliable Solar Energy Conversion Device

New converters are nearing operational status, but solar cells are gaining in efficiency as well as reliability; 25-kw arrays under study



CLOSE-UP of solar panel, part of Ranger power system fabricating program being managed by Electro-Optical Systems, Inc.

SOLAR ENERGY CONVERSION is going to continue to be carried out by solar cells for some time to come. Already 25-kw arrays are being studied for manned space station use.

Improved performance will be gained by use of V-ridge concentrators. Other types of cells—gallium arsenide, thin-film cadmium sulphide, dendritic silicon—look promising, but are expensive. They are to be evaluated in an Air Force orbital experiment.

Improved performance of thermoelectric generators is being gained with better semiconductor materials and connection techniques. Thin-film devices may radically raise output per pound.

Thermionic devices are beginning to move into the design stage and could be operating in spacecraft by 1967.

Efficiencies as high as 14% are sometimes quoted for solar cells, but systems actually in use achieve something closer to 6%. Thermoelectric devices have efficiencies in the 2-5% range.

Thermionic devices are not likely to become competitive with photovoltaics, but will probably fit into certain specific applications. Like thermoelectric systems, they require an orientation system for their energy collector. In some cases this might be already present for other reasons. They can withstand a radiation environment, but their present power conditioning systems cannot. Cesium vapor invertors are being studied as a way of getting round this. Another possibility is dc/dc conversion within the device itself.

While the efficiencies of new types of solar energy converters are being pushed to the point where an operational device becomes feasible, solar cells themselves are increasing in efficiency and gaining a growing backlog of succesful operating experience. They have much to offer in proven reliability.

● **Flight tests**—An orbital experiment planned by the Research and Technology Div. of the Air Force's Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio, will test the performance of four new types of solar panels in orbit. The vehicle will be supplied by Lockheed Missiles and Space Company.

Panel qualification tests include vibration from 5 to 2,000 cps, three shocks of 40g's, 12-g acceleration for 10 minutes, and temperature cycling from −40° to 93°C.

A cadmium-sulphide, thin-film, solar-cell panel developed for this experiment by Harshaw Chemical Com-

pany contains four 3 x 3-in. cells connected in series and weighs 20 grams. Cell efficiencies are between 2 and 3%. Cells are laminated between two sheets of Capran plastic. This, in turn, is laminated between two sheets of Mylar.

A gallium arsenide panel developed by RCA for the RTD experiment has a nominal efficiency of 8% and a predicted in-space efficiency of 6.4%. The panel, with 20 cells of 1 x 2 cm., weighs 115 grams. Cells are mounted on epoxy glass fiber secured by adhesive to aluminum. Shielding against low energy protons will be obtained with a coating of Cymel 405.

Dendritic silicon solar cell panels developed for the test by Westinghouse Electric Corporation have a nominal efficiency of 8% and are expected to show efficiencies of about 7½% in space. A panel of twelve 1 x 30-cm cells weighs 360 grams.

V-ridge concentrating panels supplied by the Boeing Co. to Lockheed for the same experiment contain four rows of cells that receive sunlight both directly and from highly polished reflectors. A concentration ratio of about 1.7 has been obtained. There is a total of forty 1 x 2-cm. silicon p on n cells, nominally 12% efficient, and the panel weighs about 102 grams.

• **Broad use**—The continuing future forseen for solar cells is emphasized in their selection as the primary power source in NASA's large space station studies. A design study carried out by the Space and Information Systems division of North American Aviation showed the feasibility of solar cell systems made up of six systems averaging 3 kw each producing 16 kw of power. Other space station designs have envisaged panels with a total output of 25 watts.

A supporting study by Hoffman Electronics concentrated on conventional silicon cells because of their cost advantages. Experiments at Table Mountain, Calif., showed that a power gain of 2.15 could be obtained with a V-ridge concentrator.

Space station studies by North American Aviation have shown that high energy proton and electron radiation is less of a threat to n on p solar cells than it is to the men on the station. For solar panels at space station altitudes, a cell life of at least three years can be expected.

Electron irradiation tests on bare n on p silicon solar cells carried out at TRW Space Technology Laboratories have resulted in a series of tables and graphs that can be used for spacecraft solar array design. Materials tested included n on p cells of 10 ohm-cm. resistivity; microsheet cover No. 0211, Corning Glass Works; interference filter No. 207SCC435-3, Optical Coating Laboratories; MgF_2 anti-reflective coating No. 511; Corning quartz covers, 0.006 in. thick, No. 7940; and modified epoxy adhesive No. X-74, Electronic Production & Development, Inc.

The adhesive was used in a 3-mil layer to bond the microsheet and quartz covers to the cells. Degradation of the adhesive was shown to be capable of contributing up to 30% of the total electrical degradation. The degradation of the cells, 11 to 14% per decade, varied between cells of the same type and was most pronounced for the short circuit current.

Although special radiation-resistant cells have been developed, there has been little demand for them. Present n on p types have proved adequate for present missions.

At this time, one of the chief problems with solar cells is the ease with which they are damaged during assembly into panels.

Efficiencies of cells have been increased by use of antireflective coatings, comb electrodes and better doping control. However, manufacturing procedures still have room for improvement as characteristics vary from cell to cell in the same production lot. This leads to difficulties in balancing series

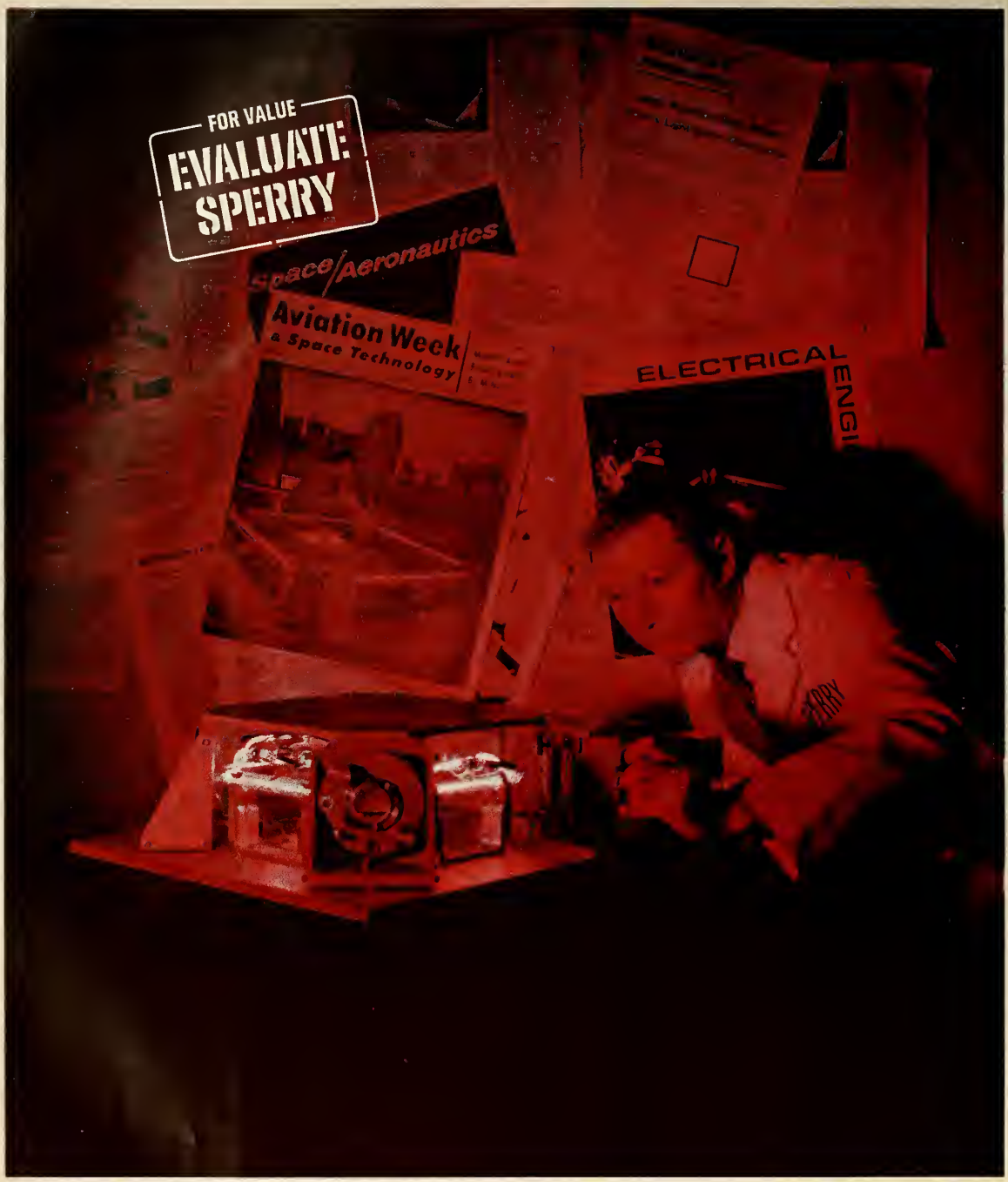


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Newest light. Several months ago Sperry announced the first new direction-sensing device in 50 years —the traveling wave ring laser. This achievement "broke ground" to make future sea, air and space guidance systems less complex, less costly . . . more reliable. □ Today, under United States Air Force sponsorship, Sperry ring laser development has taken giant strides forward, and in a short time. Pictured above is the most recent version — a lightweight ring laser which measures less than a foot across. Through counter-rotating beams of coherent light, it detects rotation rate. □ If your current project involves the problem of measurement, why not talk it over with us? Another laser achievement may be just over the threshold. *ELECTRO OPTICS GROUP, Sperry Gyroscope Company, Great Neck, New York.*

SPERRY
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and parallel combination of cells.

Greater use of the cells has led to a drop in price.

Likely future developments for solar cells include the production of thin-film cadmium sulphide cells in mylar to give a flexible array that can be draped over an entire vehicle.

Another somewhat similar approach is silicon cells that can be interconnected from a number of sides to form flexible arrays that generate a certain minimum power irrespective of the directive of the incident sunlight.

In assembly of cells into panels, soldering still appears the most suitable technique, except for near-sun missions where brazing, or possibly welding, would be needed. Induction soldering of arrays of cells is coming into increasing use, as is the use of printed circuits to interconnect cells.

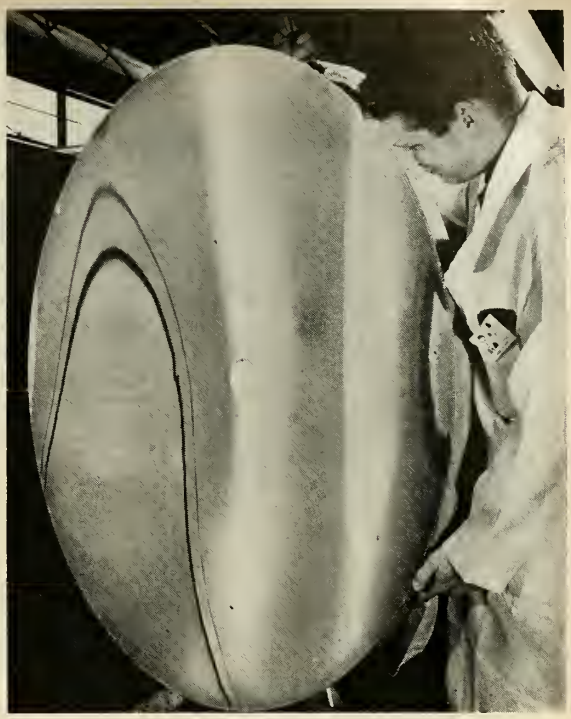
● **Other solar power**—Operational use of solar thermionic converters is about 3 years away. Electro-Optical Systems, Inc., has a program underway to develop rigid production specifications for a four-diode solar thermionic converter, which will easily withstand vibration and shock at launch. In tests on the device under development, no degradation of converter performance has occurred after 75-2,000 cps. vibration and shock at 10g's. "We think we have got the first system that could meet a launch schedule," claims Dr. Andrew O. Jensen, Manager of the Thermionic Conversion department.

The first thermionic system likely to become available would use a 5-ft. energy collector and four 30-w converters—operating at 12 watts/sq. cm. under steady dc conditions for 1,000 hours or more. A minimum system efficiency of 10% is being aimed for. Follow-on systems might use a 10-ft. solar collector.

First prototype Solar Energy Thermionic converter (SET) from EOS put out 41 watts for a solar input of 1,200 watts (3% efficiency, 2 watts per lb.). Most of the funding for this work has come from JPL, interested in using these converters on Mars missions.

Performance and endurance tests of a cesium vapor converter by General Electric yielded generator efficiencies of between 1.61 and 2.50%, depending on aperture size and operating temperature. Operation above 1,625°C degraded converter performance. A practical misorientation tolerance of ± 12 minutes of arc was attainable, causing a decrease in power of no more than 10%.

Reflectors for thermionic converters must be more accurate than other types because the solar image must be focused to a very small dot to achive the high temperatures required. At present, 10-ft.-dia. reflectors appear the likely limit for thermionic missions. The EOS 5-ft.-dia. dish for thermionic converters is produced by electroforming.



EOS all-metal, extremely lightweight, parabolic solar collector.

● **Thermoelectric generators**—Studies on high temperature (1,200°C) thermoelectric materials carried out by Monsanto Research Corp. for the Air Force indicate that thermoelectric generators weighing less than 80 lbs. per electrical kilowatt, exclusive of heat source, appear feasible. Flame and arc-plasma spraying techniques promise reduction in fabrication costs and development of mass production. Experience gained in developing a 5-watt generator (Operated 2,500 hours without degradation) has been used in the design of a 50-watt generator. This is intended for further laboratory tests and has a 78.1 lbs./kw performance, exclusive of heat source.

A 14-watt solar thermoelectric generator fabricated by Westinghouse Electric Corp. has been cycled through a simulated 90-minute Earth orbit with 55 minutes of light, and produced a constant power (±7%) for the full 90 minutes. This was achieved by using lithium hydride for thermal storage. The couples were made of p material (0.95 GeTe + 0.05 BiTe) and n material (PbTe + 0.1% Bi). A conversion efficiency of 3.55% was obtained. Projections indicate that a 300-watt unit can be built with a power-to-weight ratio of 2-3 watts/lb. and an efficiency of 5%. More precise orientation is required than for solar cells, but not as precise as for thermionic devices.

Work at the Ohio Semiconductors Div., Tecumseh Products Co., has emphasized the importance of good electrical contacts in the realization of improved efficiencies, and led to a prediction of outputs of 1.27 Mw/lb., if thin-film techniques are used.

Honeywell's Research Center, Minneapolis, Minn., is carrying out a three-year program sponsored by the Air Force Materials Laboratory to develop surfaces that absorb solar energy, concentrated at short wavelengths, but have low infra-red emittance. One technique studied is use of layers of thin metals and dielectrics to form interference films. Another is use of materials that are selectively black in the solar region. Honeywell is doing this by doping materials with transition elements.

Inflatable collectors of solar energy are being developed by Hughes Aircraft Company. Under contract from NASA Langley Research Center, five-foot experimental models are to be produced. The reflectors will be fabricated from aluminum-coated mylar, backed by a pliable polyester resin. A transparent membrane on the front of the mirror traps air that draws the plastic taught in a vacuum. UV rays from the sun then harden the resin. Parabolic reflectors 100 ft. in diameter are the ultimate aim of the development program, says Hughes. ■

AWARDS

AIR FORCE

$6,200,000—**S & S Constructors,** Lancaster, Calif., for construction of a rocket test stand, including all controls and utilities for testing liquid or solid-fuel engines, at Edwards AFB, Calif.

$2,800,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for production of *Thor* space boosters.

$1,485,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued studies of advanced liquid propellant rocket engines.

$1,400,000—**Cook Electric Co.,** Morton Grove, Ill., for follow-on work on intersite carrier cable communications systems equipment.

$1,300,000—**Hughes Aircraft Co.,** Fullerton, Calif, for work on advanced radar equipment.

$1,300,000—**General Electric Co.,** Syracuse, N.Y., for advanced radar components.

$1,200,000—**Bendix Corp.,** Eatontown, N.J., for electrical components for use in air-to-surface missiles.

$1,000,000—**Avco Corp., Lycoming Div.,** Stratford, Conn., for continued work on re-entry vehicles.

$172,000—**Scientific-Atlanta, Inc.,** Atlanta, Ga., for development of advanced instruments to improve the state of the art in antenna pattern recording techniques.

$70,500—**Lockheed-Georgia Co.,** Marietta, Ga., for development of an integrated test battery to assess performance effects of environmental stresses associated with aerospace flight.

$62,500—**Sylvania Electric Products, Inc.,** Buffalo, N.Y., for an investigation of techniques for transmission of radio signals in the presence of interference.

$39,900—**Benrus Watch Co.,** Waterbury, Conn., for a guided missile launcher assembly.

ARMY

$12,500,000—**Sylvania Electric Products, Inc.,** Needham, Mass., for work on a classified electronics system.

$12,300,000—**American Telephone and Telegraph Co.,** New York City, for guidance equipment related to the *Nike-Hercules* missile system.

$2,600,000—**Sperry Rand Corp.,** Great Neck, N.Y., for radar components.

$1,900,000—**North American Aviation, Inc.,** Columbus Div., Columbus, Ohio, for initial production of *Redhead-Roadrunner* guided target missile systems.

$1,400,000—**University of Colorado,** Boulder, for research in astrophysics.

$223,206—**Fruehauf Corp.,** Detroit, Mich., for engineering services related to ground support vehicles for the *Nike* missile system.

NAVY

$8,276,000—**Burroughs Corp.,** Paoli, Pa., for production of five data processing systems.

$4,636,000—**Aerojet-General Corp.,** Sacramento, Calif., for *Tartar* missile rocket motors.

$3,200,000—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for modification of SINS inertial navigation equipment for 16 *Polaris* FBM submarines.

$2,131,090—**General Electic Co.,** Erie, Pa., for production of generators and aircraft control panels.

$2,000,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., for communications equipment for a Marine Corps tactical data system.

$1,900,000—**American Telephone and Telegraph Co.,** New York City, for sound signal processing equipment.

$1,300,000—**Adams Russell Co.,** Waltham, Mass., for radar antenna equipment.

$300,000—**Informatics, Inc.,** Sherman Oaks, Calif., for studies of future naval tactical data systems.

$37,171—**General Electric Co. Missile and Space Div.,** Philadelphia, for a study to determine angular motion of a gravity-gradient stabilized satellite system.

Westinghouse Electric Corp., Defense and Space Center, Baltimore, for a study of the feasibility of advanced manned mobile systems for the Navy's advanced sea-based deterrent program (amount undisclosed).

NASA

$1,586,563—**Hayes International Corp.,** Birmingham, Ala., for engineering and fabrication services relating to the *Saturn V* launch effort.

$100,000—**Marshall Laboratories,** Torrance, Calif., from Jet Propulsion Laboratory for fabrication of a single-axis seismometer and the design and fabrication of associated checkout equipment, for use on the *Surveyor* spacecraft.

$78,318—**Sylvania Electronic Systems,** Applied Research Laboratory, Waltham, Mass., for design and construction of a high-accuracy optical device capable of receiving laser signals in space communications.

$77,350—**Douglas Aircraft Co., Charlotte, Div.,** Charlotte, N.C., for design and fabrication of second stages for two *WASP* sounding rockets.

$60,320—**Ampex Corp.,** Huntsville, Ala., for an airborne portable tape recorder.

The Boeing Co., Seattle, Wash., from Jet Propulsion Laboratory, for testing and evaluation of resistors for space application (amount undisclosed).

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DEPARTMENT OF DEFENSE

$1,600,000—**General Applied Science Laboratories, Inc.,** Westbury, N.Y., from the Advanced Research Projects Agency for classified work in aerospace physics problems.

INDUSTRY

$5,800,000—**Austin Co.,** Cleveland, Ohio, from **The Boeing Co.,** Seattle, Wash., for construction of space research buildings and related utilities at Kent, Wash.

$600,000—**Whittaker Corp., Controls and Guidance Div.,** Los Angeles, from **TRW Space Technology Laboratories,** Redondo Beach, Calif., for design and development of fuel controls for the *Apollo* Lunar Excursion Module.

$100,000—**Radar Relay, Inc.,** Santa Monica, Calif., from **North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for supply of master caution and event warning annunciator assemblies for the *Apollo* test spacecraft.

$74,000—**Aluminum Co. of America,** Vernon, Calif., from **The Boeing Co.,** Seattle, Wash., for electronic cabinet base castings for use in *Minuteman* launch control centers.

$30,000—**Electronic Memories, Inc.,** Hawthorne, Calif., from **The Budd Co., Electronics Div.,** New York City, for a severe-environment core memory system.

Fairchild Space and Defense Systems, Syosset, N.Y., from **Litton Industries, Inc.,** of Los Angeles, for design, development and fabrication of star tracker telescopes (amount undisclosed).

United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn., from **Douglas Aircraft Co., Missile and Space Systems Div.,** Santa Monica, Calif., for a design study of an environmental control and life support subsystem for a six-man orbital research laboratory (amount undisclosed).

Westinghouse Electric Corp., Defense and Space Center, Baltimore, Md., from Centres National D'Etudes Spatiales, Paris, France, for electron subsystems for the *FR-1* scientific satellite (amount undisclosed).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Headquarters, Contracts, Code BCA
Washington, D.C. 20546

Studies on planetary meteorology of Mars, Venus and Jupiter. NASA is negotiating a contract with Geophysics Corp. of America, Bedford, Mass. No RFP available. For information only.

National Aeronautics and Space Administration
Headquarters, Contracts, Code BCA
Washington, D.C. 20546

Bounded pbase coordinate controls for large flexible launcb boosters. NASA is negotiating a contract with Minneapolis-Honeywell Regulator Co., Military Products Group Researcb Laboratory, Minneapolis, Minn. No RFP available. For information only.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Researcb Procurement Brancb
Houston, Tex.

A study of ballistic orbital support operations. Anticipated contract will involve engineering analysis and preliminary spacecraft design, including subsystems analysis. RFP MSC 64-1348P due 6/19/64.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston, Tex.

Develop carbon electrodes for use with MSC Solar Simulator System. RFP MSC-64-1233P due 6/18/64. Cost proposal due no later than 6/26/64. RFP available through 6/12/64.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif. 94035

Design study fabrication and delivery of laboratory model Sun sensors, four each, and one Sun sensor tester. RFP A-8517 due 6/8/64.

Research and Development Procurement Office
U.S. Army Engineer Research and Development Laboratories
Fort Belvoir, Va. 22060

Negotiations will be conducted with Midwest Research Institute, 425 Volker Blvd., Kansas City, Mo., for a researcb study covering the design of a laser experiment. Procurement is a follow-on to previous work. RFP not available. For information only.

National Aeronautics and Space Administration
Headquarters Contracts
Washington, D.C. 20546

Survey covering acquisition, compilation, evaluation and organization of material describing scientific space instruments and experiments and preparation of space measurements survey handbook. NASA is negotiating contract witb Electro-Optical Systems, Inc., Pasadena, Calif. For information only. No RFP available.

National Aeronautics and Space Administration
Headquarters Contracts
Washington, D.C. 20546

Researcb study to determine tbe feasibility of using the fustrated multiple internal reflection (FMIR) spectroscopy tecbnique to obtain infrared absorption spectra of powders and films. NASA is negotiating contract with Phillips Laboratories. RFP not available. For information only.

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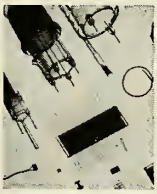
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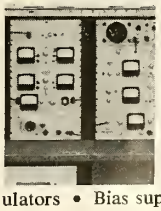
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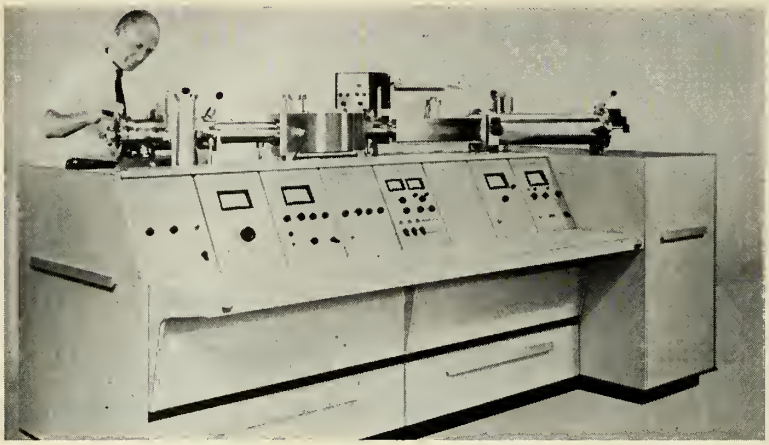
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New Product of the Week: Mass Spectrometer

Consolidated Electrodynamics Corp. has developed a mass spectrometer incorporating both electrical and photoplate detection methods.

The Type 21-110B offers versatility through a combination detector which makes possible alternate use of the photoplate, electrometer and electron multiplier and permits switching from one detection mode to another without disturbing the instrument's internal vacuum. Developers say the device will separate masses differing as little as one part in 20,000 and will accept ion sources and ion detectors for all types of research problems. The spectrometer has a gas source, an RF spark source, a Knudsen Cell and a surface ionization source.

Circle No. 151 on Subscriber Service Card

Radiation Resistant Solenoid

A radiation resistant solenoid, designed for complex aerospace applications, is being marketed by Tec Magnetics.

The Model 24TM1072 has an operating temperature range of —65° to over 1,000°F. Rated force is 12 lbs. at 0.04 stroke at 48v dc. The device is manufactured from inorganic materials to withstand gamma rays. It is available with pressurized or non-pressurized plunger cavaties with extensions to fit particular applications.

Circle No. 152 on Subscriber Service Card

Variable Inductor Kits

Sangamo Electric Co. is marketing a line of variable inductor kits covering a 2.7 mh to 1.10 h range.

The kits are designated 101A, 101B and 102. Kit 101A has a nominal inductance range from 3.3 mh to 1.0 h in 20% steps. Range of 101B is 3.0 mh to 0.91 h in 20% steps. Kit 102 covers the 3.0 mh to 1.0 h range in 10% steps. Guaranteed tuning range of all units is ±10%.

Circle No. 153 on Subscriber Service Card

Multibeam Phased Array

Advanced Development Laboratories, Inc., is marketing a 64-element multibeam phased array capable of generating a total of 15 beams, eight uniformly illuminated and seven cosine tapered.

The Model 02-13 operates in a frequency range of 2.5 to 2.9 gc, and has a beamwidth in the azimuth plane of 5 degrees and 20 degrees in elevation. Total azimuth coverage is 40 degrees. The sidelobe level is maintained at —10 db maximum; ellipticity is measured at 2 db. The unit meets MIL-E-5400 specifications.

Circle No. 154 on Subscriber Service Card

Precision Resistors

A line of precision resistors, featuring a metal film rather than a tin oxide or glazed resistive element, has been introduced by Electra Manufacturing Co.

The ¼ and ½-watt units meet MIL-R-22684A specifications and have a temperature coefficient range of ±150

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Eimac

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ppm/°C. Both units are rated at 70°C with a —55° to 150°C temperature range. Delta R load life is 1.5% at rated temperature and power for 1,000 hours. The ½-watt Model MF20C has a resistance range of 51.1 ohms to 470 K; the ¼-watt Model MF07C has a resistance range of 51.1 ohms to 150 K.

Circle No. 155 on Subscriber Service Card

Transistor

A transistor capable of delivering 10 milliwatts of fundamental oscillator power at 3 gc has been announced by Texas Instruments, Inc. The Model 3023 is designed for applications requiring power from VHF to 5 gc. A second device in the series, Model 3024, is characterized for applications requiring low noise figure and small-signal performance from VHF to 3 gc.

Model 3023 has a guaranteed gain-bandwidth product of 2.4 gc, oscillator power output of 10 mw minimum at 3 gc, and 30 mw minimum at 1 gc. Minimum f_T is 2.4 gc; and $r_b'C_c$ is 6.0 psec maximum.

Model 3024 has a guaranteed noise figure of 5 db maximum at 1 gc, guaranteed minimum gain-bandwidth product of 1.5 gc and guaranteed $r_b'C_c$ of 3 psec maximum.

Circle No. 156 on Subscriber Service Card

Potentiometric Voltmeter

A six-dial guarded potentiometric voltmeter that permits infinite impedance measurements from 0 through 1,000v has been introduced by Honeywell's Denver Div.

The Model 852 is a solid-state unit with a 10-megohm minimum impedance null detector and over-ranging on all dials. The unit consists of a 1,111.11-v dc reference, a 6-dial divider and the null detector. Instrument accuracy is ±0.02% of reading. Dial resolution is 0.0001% on all ranges. Resolution of the null detector is 1.0 mv. Line regulation is 0.0005% maximum change for line change of ±10% from 120v, 5 to 60 cps.

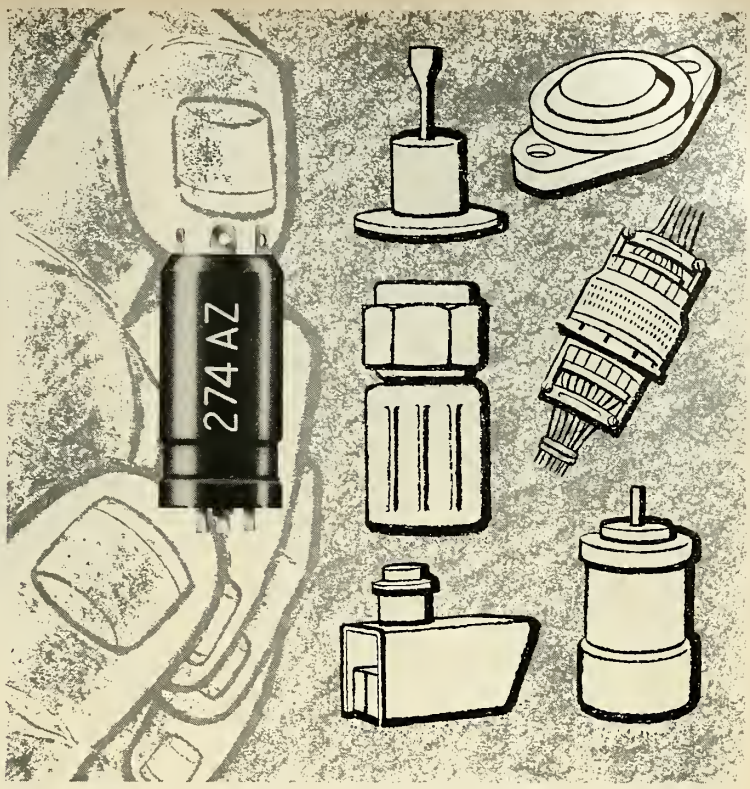
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Thermoplastic

Saunders Engineering Corp. has introduced an ultra-high-molecular-weight thermoplastic with tensile impact three to four times that of nylon or polycarbonates.

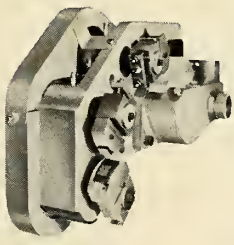
The S920 "Impacto" offers IZOD impact strength greater than 20 ft.-lbs. per inch of notch and tensile impact more than 1,000 ft.-lbs. per sq. in., according to ASTM test methods. The material can be applied for service to —420°F and can be alloyed with metals or fibrous filters. It is available in rod, tube and sheet forms.

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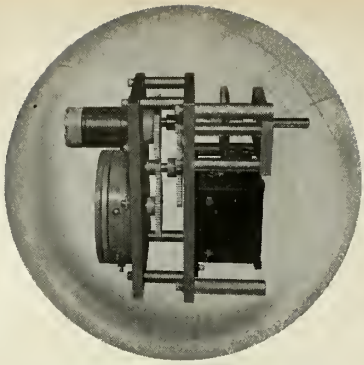
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Tunable Garnet Filter

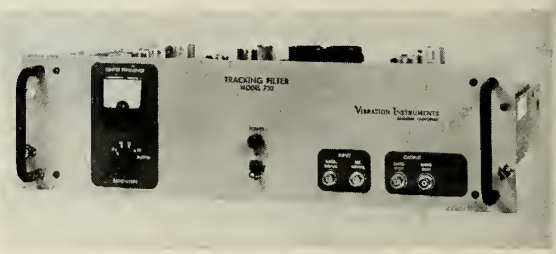
The Model S402 two-section electronically tunable garnet filter for the octave band of 250 to 500 mc is available from Airtron Div. of Litton Industries.

The device offers a 6-db maximum insertion loss, 3% nominal bandwidth, saturation level of −10 db and spurious rejection of −30 db minimum at f_0 ±10%. The filter is the first of a series being developed to cover the 125 to 18,000-mc microwave spectrum.

Circle No. 159 on Subscriber Service Card

Tracking Filter

The Model 730 tracking filter, using phase-lock circuitry and quartz crystal filtering, is available from Vibration Instruments Co. The unit is especially adaptable to



filtering accelerometer signals in sine/random vibration test systems.

The bandwidth switching circuit allows the user to select 5-, 10-, 25- or 50-cps bandwidths and eliminates the need for separate filter modules. Overall frequency range is 5 to 5,000 cps. Five versions of the filter are available, incorporating additional features such as bandstop filtering, automatic bandwidth switching and recording capabilities.

Circle No. 160 on Subscriber Service Card

Power Converter

A miniature converter that produces regulated outputs of up to 5 kv at 40 watts from an input of 25 to 30v dc is available from Arnold Magnetics Corp.

The Model SHU measures 2⅛ x 3 5/16 x 3⅝ in. and meets MIL-E-5272 specifications. Output may be adjusted +5% and −10% from nominal value. Ambient temperature range is −55° to 71°C.

Circle No. 161 on Subscriber Service Card

Infrared Emitter

A gallium arsenide infrared emitter that delivers a band of incoherent IR energy at 9,000 Å is being marketed by Raytheon Co.'s Special Microwave Devices Operation.

The Model RSE-1 has a CW light source which is a 1-sq.-mm. chip of gallium arsenide mounted inside a TO-5 can with an optical quality window. A current of 20 milliamperes initiates the infrared emission in either a pulsed or CW mode.

Circle No. 162 on Subscriber Service Card

Vacuum Valves

A line of non-sticking vacuum valves that have no sliding seals and do not require lubrication has been announced by Humphrey Products.

The basic mechanism of the valves consists of two diaphragms (poppets) which are pushed by atmospheric pressure into conical seats. When the valve closes, the diaphragm is literally sucked into its seat by the vacuum. The units are available in 1/16, ⅛, ¼ and ½-in. internal orifice sizes, for 2, 3 or 4-way service handling vacuum of 0 to 29.5-in Hg.

Circle No. 163 on Subscriber Service Card

Circle No. 28 on Subscriber Service Card

Digital Logic Cards

Computer Logic Corp. is marketing a series of digital logic cards designed for application in counting, storage and shifting operations.

The Model QF-21 contains four independent flip-flops with set-reset-toggle diode gates. By wiring at the socket, the flip-flops may be interconnected to provide set-reset storage, to provide toggle action so as to count in binary or in any number base or to operate as a shift register. Counters may be clocked so all flip-flops respond at the same instant or ripple-carries between stages may be used.

Circle No. 164 on Subscriber Service Card

CW Laser Crystal

Union Carbide Corp.'s Linde Div. is producing large single crystals of yttrium aluminum garnet (YAG) that can be heavily doped with rare earth materials.

Researchers report that the crystals doped with trivalent neodymium provide laser action at room temperature in both pulsed and CW operation. Emission spectra are simplified because YAG does not require charge compensation and the crystals exhibit narrower fluorescent linewidths and an order of magnitude lower threshold than other crystals.

At room temperature, YAG crystals can be lased in the CW mode with approximately 360 watts dc supplied to a tungsten lamp. Laser efficiency is increased by the ability to employ concentrations of dopants in excess of 50% normal.

Circle No. 165 on Subscriber Service Card

Decade Amplifier

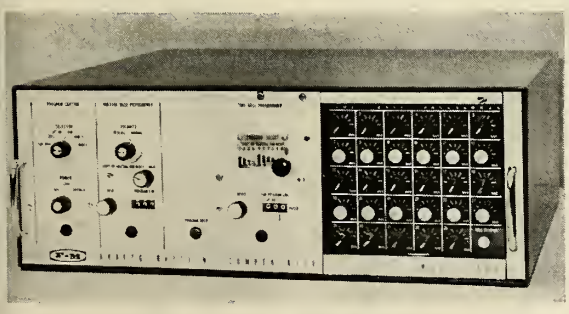
Arvee Engineering Co. is marketing a series of all-transistor decade amplifiers with frequency responses from below 5 cycles to 1 mc.

The series features voltage gains of 1, 10 or 100. Equivalent input noise is less than 2.5μv and harmonic distortion is under 1%. The units employ high-gain silicon transistors in the input stages to insure temperature stable low level operating points and low noise performance.

Circle No. 166 on Subscriber Service Card

Analog Baseline Compensator

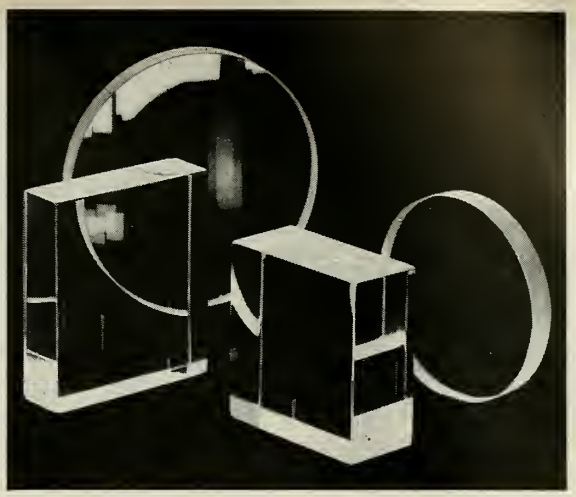
An analog baseline compensator for use in single-column programmed temperature gas chromatography has been introduced by F & M Scientific Corp. The device makes use of an electrical function generator to produce an analog



signal to compensate for substrate bleeding.

The Model 280 produces an analog signal that is of opposite polarity to the bleed line signal and, when added to the bleed line signal, eliminates a rising baseline. Variations in bleed level resulting from liquid phase depletion are automatically corrected.

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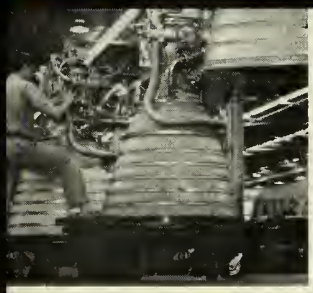
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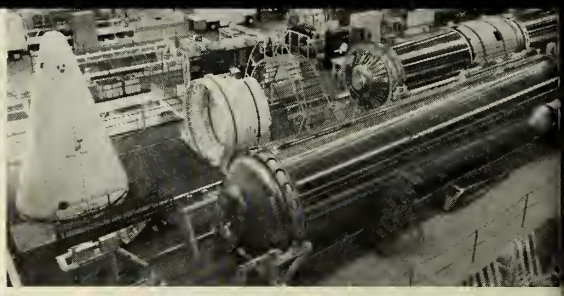
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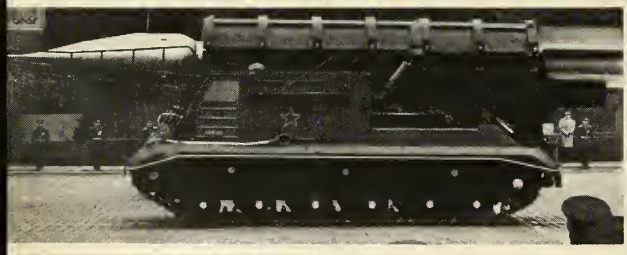
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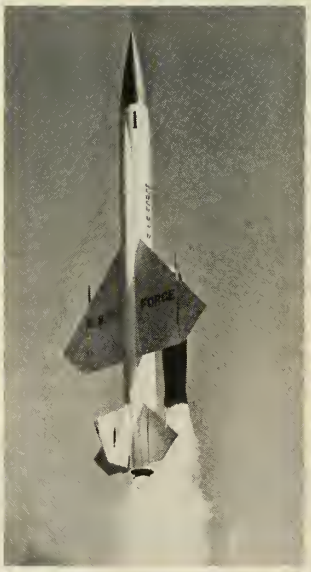
























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names in the news


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Robert W. Galvin: Elected chairman of the board and chief executive officer of Motorola, Inc., Franklin Park, Ill. **Elmer H. Wavering:** Elected Motorola president, succeeding Galvin.

John Hanway II: Elected vice president-administration of International Telephone and Telegraph Corp., New York.

Dr. Donald D. King: Named director of the Electronics Research Laboratory, Aerospace Corp., El Segundo, Calif.

Don M. Marshall: Named general manager of Republic Aerospace Corp., Montauk, N.Y.

Robert A. Leonard: Named vice president, director of systems design and programming for Data and Information Systems Div., International Telephone and Telegraph Corp., Paramus, N.J.

T. A. Wilson: Appointed vice president-operations and planning of The Boeing Co., Seattle, Wash.

D. S. Kerr: Appointed commercial vice president of Allis-Chalmers with headquarters in Atlanta, Ga.

John P. Endicott: Appointed executive vice president and elected a director of Babcock Electronics Corp., Costa Mesa, Calif.

Allan G. Piersol: Appointed vice president of Measurement Analysis Corp., Los Angeles.

W. Joseph Eaton: Elected vice president-engineering of Menasco Manufacturing Co., Burbank, Calif.

Rudy Chiodo: Appointed president and general manager of Protran Co., Inc., Hicksville, N.Y.

Boyce Nemec: Elected vice president of Reeves Industries, Inc., New York City.

Joseph W. Devorss: Appointed director of the government department, United States Rubber Co., New York City.

Frank E. Stehlik: Elected vice president-finance, secretary and treasurer of Baldwin-Lima-Hamilton Corp., Philadelphia.

Abbott A. Rosenberg: Appointed technical publications supervisor of Computer Measurements Co., San Fernando, Calif.

Edward J. Wagner: Appointed plant manager of the Ball Div., Industrial Tectonics, Inc., Ann Arbor, Mich.

Robert E. Ellett: Appointed general manager of Burtek, Inc., Tulsa, Okla., a subsidiary of Aircraft Armaments, Inc., Cockeysville, Md.

Robert L. Wendt: Named assistant manager of the *Polaris* management group at Sperry Gyroscope Co., Great Neck, N.Y.

R. E. Whiffen: Appointed general manager of the Friez Instrument Div., The Bendix Corp., Baltimore, Md.

William M. Freeman: Elected vice president of Chicago Bridge & Iron Co., Oak Brook, Ill.

J. Richard Vyce: Joined Itek Corp.'s Optics Div., Lexington, Mass., as senior staff assistant.

Dean R. Barker: Joined Electro-Optical Div. of the Perkin-Elmer Corp., Norwalk, Conn., with responsibilities centering on advanced systems program planning.

Harry T. Larson: Appointed manager of electronic systems technology programs at Philco Corp.'s Aeronutronic Div., Newport Beach, Calif.

John G. McKinley: Appointed deputy director of science and technology at Westinghouse Defense and Space Center's Aerospace Div., Baltimore.

Technical Sergeants Nicholas Markellos, William E. Linker and Julius Crochet, USAF: Killed when a *Sidewinder* missile exploded while being installed on an F-104 aircraft at Tyndall AFB, Florida.

Peter S. Thomas: Named a sales representative for the General Electric Silicon Products Dept., Oak Park, Mich.

John R. O'Brien: Appointed vice president of Victory Electronics, Inc., Syosset, N.Y., in charge of the Washington, D.C. office.

Roderic A. Spies: Promoted to sales manager of Washington Technological Associates, Inc., Rockville, Md.

William M. Freeman: Appointed general manager of Chicago Bridge and Iron Co.'s International Div., Oak Brook, Ill.

Clifford S. Duxbury, Jr.: Appointed manager of the public relations section of Norton Co.'s Advertising and Public Relations Dept., Worcester, Mass.

Alfred F. Sammet: Appointed manager of commercial computer sales for the Commercial Computer Div. of General Precision, Inc.'s Librascope Group, Burbank, Calif.

Edwin H. Meier: Appointed director of the research and development division of Hughes Aircraft Co.'s aerospace group, Culver City, Calif.

Robert A. Huff: Named manager of product publicity for Electronic Associates, Inc., Long Branch, N.J.

Thomas R. Sergeant: Appointed vice president of engineering at Phillips International Co., Natick, Mass.

Lt. Col. R. D. Dunn (USA Ret.): Joined Brooks & Perkins, Inc., Detroit, as manager-military requirements in the Defense Products Div.

Clinton W. Hartman: Elected vice president-electronics of CTS Corp., Elkhart, Ind.

Peter R. Wiederhold: Joined the staff of Magnion, Inc., Burlington, Mass., as manager of the superconducting magnet and cryogenic department.

Michael J. Samek: Appointed director of marketing and sales for IT&T's Data and Information Systems Div., Paramus, N.J.

Robert Young: Named director of planning at Cook Electric Co.'s Data-stor Div., Skokie, Ill.

Robert B. Ames: Named general manager of the General Electric Tube Dept., Owensboro, Ky.

Morris E. Parker: Appointed general manager of Varo, Inc.'s new facility at Mexia, Tex.

Dr. Lewis Larmore: Appointed director of the Douglas Aircraft Co.'s Corporate Advanced Research Laboratory, Huntington Beach, Calif.

A. John Esserian: Appointed manager of personnel and industrial relations for the Physics Research Div. of Geophysics Corp. of America, Bedford, Mass.

Richard F. Musson: Named applications sales manager for the Commercial Computer Div. of the Librascope Group of General Precision, Inc., Burbank, Calif.

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JUNE

10th National Analysis Instrumentation Symposium, "Advances in Analytical Instrumentation for Measurement and Control," Instrument Society of America, Sheraton-Palace Hotel, San Francisco, June 1-3.

National Telemetering Conference, AIAA, IEEE and ISA, Biltmore Hotel, Los Angeles, June 2-4.

National Symposium on Global Communication (GLOBECOM VI), IEEE, University of Pennsylvania and Sheraton Hotel, Philadelphia, June 2-4.

Society of Plastics Engineers Meeting on Stability of Plastics, Sheraton-Park Hotel, Washington, D.C., June 4.

Electromagnetic Window Symposium, sponsored by Atenna Laboratory Dept. of Electrical Engineering, Ohio State University, and Research and Technology Div., USAFSC, Columbus, Ohio, June 2-4.

Symposium on Quasi-Optics, sponsored by Polytechnic Institute of Brooklyn, IEEE, U.S. Army Research Office, U.S. Air Force and U.S. Navy, Statler-Hilton Hotel, New York City, June 8-10.

Seminar on "Computer Applications to Structural Engineering," Illinois Institute of Technology Research Institute, Chicago, June 10.

Systems Engineering Conference and Exposition, New York Coliseum, New York City, June 8-11.

Sixth National Electromagnetic Compatibility Symposium, IEEE, Los Angeles, June 9-11.

National Electronic Packaging Conference, New York Hilton Hotel, New York City, June 9-11.

Eighth Annual Product Engineering and Production Conference, IEEE, Pratt Institute, Brooklyn, N.Y., June 11-12.

10th Annual Meeting, American Nuclear Society, Sheraton Hotel, Philadelphia, June 14-17.

20th Annual National Meeting of the Institute of Navigation, Barbizon Plaza Hotel, New York City, June 15-17.

Symposium on Molecular Structure and Spectroscopy, OSU, ONR, NSF, Ohio State University, Columbus, Ohio, June 15-19.

Summer Scientific Seminar on Communication Cybernetics, sponsored by the Air Force Office of Scientific Research, Cloudcroft, N.M., June 15-26.

International Conference on Physics and Chemistry, sponsored by the Air Force Office of Scientific Research, Brown University, Providence, R.I., June 21-26.

Seminar on Microcircuit Equipment, Mesa Scientific Corp., Ambassador Hotel, Los Angeles, June 22-23.

67th Annual Meeting, American Society for Testing and Materials, Chicago, June 22-24.

International Conference on Photosensitization in Solids, sponsored by the Air Force Cambridge Research Laboratories, Office of Naval Research, Space Physics Laboratory and Illinois Institute of Technology, Chicago, June 22-24.

Seventh Molecular Beam Conference and Institute on Molecular Beams, sponsored by AFOSR, Brookhaven National Laboratory and Uppsala University, Uppsala, Sweden, June 22-July 7.

Conference on Precision Electromagnetic Measurements, sponsored by National Bureau of Standards, IEEE and International Scientific Radio Union, NBS Boulder Laboratories, Boulder, Colo., June 23-25.

11th Annual Symposium on Computers and Data Processing, University of Colorado, Elkhorn Lodge, Estes Park, Colo., June 24-25.

Fifth Joint Automatic Control Conference, Stanford University, Stanford, Calif., June 24-26.

International Symposium, Fundamental Phenomena in Hypersonic Flow, Cornell Aeronautical Laboratory, Buffalo, N.Y., June 25-26.

1964 Conference on Aerospace Education, National Aerospace Education Council, Hotel Mayflower, Washington, D.C., June 25-27.

First Annual Meeting and Technical Display of the AIAA, Sheraton-Park Hotel, Washington, D.C., June 28-July 2.

Aerospace Reliability and Maintainability Conference, sponsored by SAE, ASME and AIAA, Statler Hilton Hotel, Washington, D.C., June 29-July 1.

First International Congress on Vacuum in Space Research, French Society of Vacuum Engineers and Technicians, Paris, France, June 29-July 3.

JULY

Annual Meeting of National Society of Professional Engineers, Grove Park, Inn, Asheville, N.C., July 1-4.

Seminar in Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries, sponsored by the Contract Management Institute, Savoy Hilton Hotel, New York City, July 6-10.

Concentrated Vortex Motions in Fluids, AFOSR, ONR, NSF, NASA and International Union of Theoretical and Applied Mechanics, University of Michigan, Ann Arbor, July 6-11.

20th Interagency Solid Propulsion Meeting, Sheraton Hotel, Philadelphia, July 12-15.

Fourth International Symposium on Rarefied Gas Dynamics, sponsored by the AF Office of Scientific Research, Office of Naval Research, NASA and the University of Toronto, University of Toronto, Canada, July 14-17.

National Aerospace Electrical/Electronic Symposium, "Supersonic Aircraft—Avionics at Mach 3 and Beyond," Aerospace Electrical Society, International Hotel, Los Angeles, July 14-15.

International Congress on Semiconductor Physics, sponsored by the AF Office of Scientific Research, NSF, ONR and International Union of Pure and Applied Physics, Paris, France, July 20-24.

Gordon Research Conference on Critical Tables and Progress in Science, Air Force Office of Scientific Research, New Hampton, N.H., July 20-24.

AUGUST

Seminar in Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries, sponsored by the Contract Management Institute, Ambassador Hotel, Los Angeles, Aug. 3-7.

First Research Conference on Instrumentation Science, ISA, William Smith College, Geneva, N.Y., Aug. 3-7.

Structural Developments in Inorganic Chemistry and Their Chemical Implications, AFOSR, New Hampton, N.H., Aug. 10-14.

International Astronomical Union Symposium No. 25, sponsored by AFOSR, International Astronomical Union, government of Greece and University of Thessaloniki, Thessaloniki, Greece, Aug. 17-22.

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Dr. Fubini

or: How I Learned to Stop Worrying and Love ComSat Corp.

THE ABRUPT ABOUT-FACE by the Dept. of Defense which has brought it into discussions with the Communciations Satellite Corp. and which has further delayed acquisition of a military communications satellite system continues to puzzle much of the industry.

The lame explanation that DOD suddenly discovered at this late date, much to its surprise, that ComSat Corp. was indeed interested in the lucrative military business fails to hold water. It hardly seems reasonable that the nation's cost-conscious Secretary of Defense had not already weighed the savings involved in such an alliance and concluded that sound technical military reasons existed which made such an approach impractical.

The protracted negotiations between the two organizations tend to support this belief. The difficulties obviously are considerable.

Dr. Eugene G. Fubini, DOD's deputy director for research and engineering, already is far past the April 30 deadline he set for agreement on joint requirements.

"That date was an arbitrary deadline I gave myself," Dr. Fubini explains. Unfortunately for Dr. Fubini's peace of mind he also gave it to Congress and the press. The DOD executive remains confident, however, that the Pentagon will reach agreement with ComSat Corp. on joint use of a medium-altitude satellite communications system, although he concedes that every day in which there is no agreement means further slippage in the military communications satellite program.

Dr. Fubini also continues to reject any consideration of a synchronous satellite development, another puzzle to some segments of the industry.

There is a mounting suspicion that a sudden White House interest in the communications satellite picture upset the methodical Defense Dept. approach to the military requirements for satellite communications. Meanwhile, DOD continues to pour out money to keep its program definition project under way with Philco and TRW/Space Technology Laboratories.

This snag in the effort to develop an effective military system is but the latest in a long line of troubles which have plagued DOD's communications satellite effort.

Seven years ago, Gen. Bernard Schriever discussed with the Pentagon's research director, Dr. Herbert York, the urgent need for a military communications satellite program.

"I expressed the belief that we should proceed with such a satellite system because communications was one of the most critical elements of our overall command and control system," Gen Schriever says.

In a hearing before a House Government Operations subcommittee almost two years ago, Gen. Schriever described the system as vital and outlined the reasons why a military system and a commercial system are incompatible. In view of the latest developments, we think it worthwhile to review what he said at that time:

"The use of presently suggested civil commercial satellite systems to handle military administrative peacetime traffic is clearly possible to the extent that economical services can be provided to the required location. The use of such systems to meet the nation's military command and control requirements, however, is made extremely difficult in some cases and impossible in others because of the basic incompatibility between the characteristics of civil commercial systems and the requirements of military command and control systems."

Gen. Schriever went on to outline these incompatible characteristics:

- Commercial satellite systems are designed for capacities of hundreds of standard voice channels, while military command and control systems are characterized by very few voice, teletype or digital data channels.

- Commercial design emphasizes operations between large, elaborate, fixed, point-to-point terminals located a few hundred miles from major national population centers, while the military requirement is for numerous terminal locations, some quite remote from the probable civilian trunk terminal locations and others whose locations will be determined only by future international events. For limited warfare, terminals will have to be transportable or even mobile.

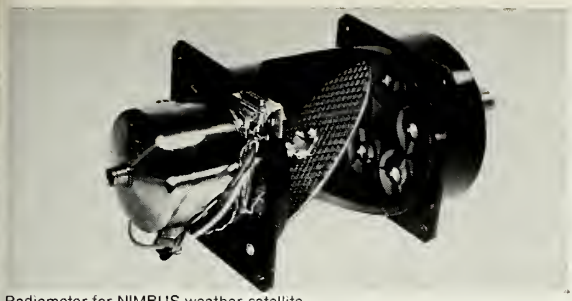
- Unlike military systems, the commercial system is designed to operate under international agreement in civilian frequency channels and in a cooperative electronic and physical environment. "I think it is extremely important to recognize that this jeopardizes and compromises national security needs just when you need them most," Gen. Schriever declared.

- Unlike commercial systems, the military system requires cryptographic security on most of the circuits and, in addition, anti-jamming protection against concerted enemy electronics attack is a vital necessity. Cryptographic security requires the use of nonstandard speech modulation messages which probably will not be compatible with the standard commercial speech channel. Protection against electronic attack requires use of a much larger ratio of radio frequency bandwidth to information bandwidth than would be normally used in a commercial system.

"I think that we have a very definite requirement for a defense communications system. That doesn't mean that we will not be using civilian satellites on a lease basis, just as we now use cables and telephone lines, and so forth," Gen. Schriever declared. "(But) I feel very strongly that we need to get on with this program as fast as we possibly can."

IN VIEW OF SUCH an explicit statement, we believe further explanations of the ComSat Corp. negotiations are in order.

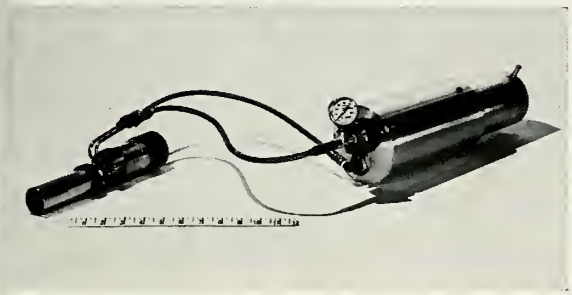
William J. Coughlin



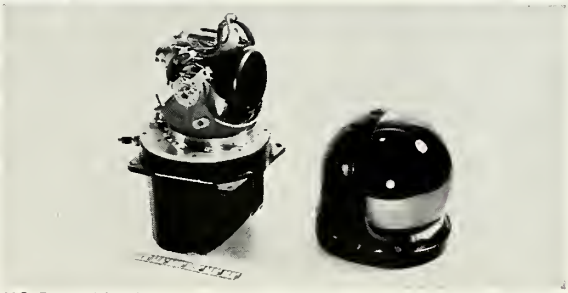
Radiometer for NIMBUS weather satellite



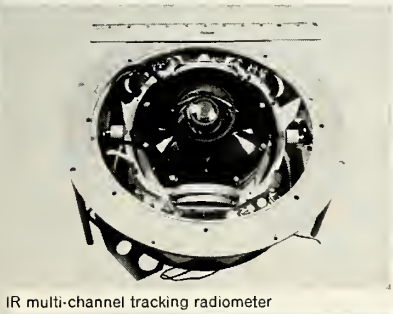
Interceptor IR installation



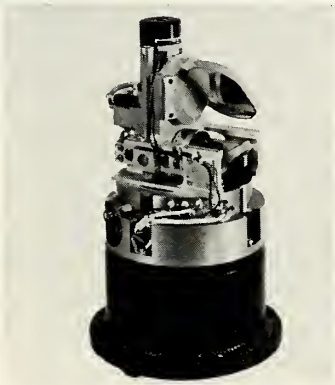
12°K closed-cycle cryostat



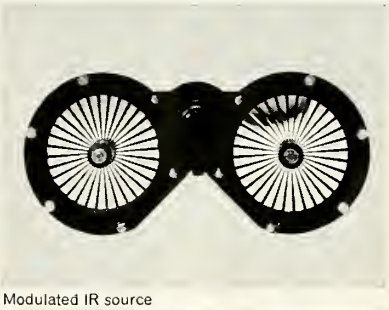
90C IR search/track set



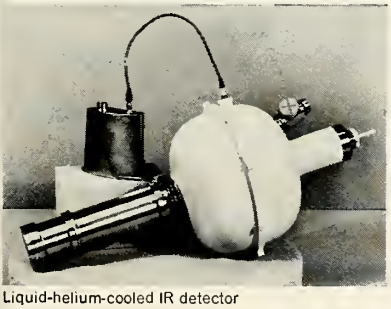
IR multi-channel tracking radiometer



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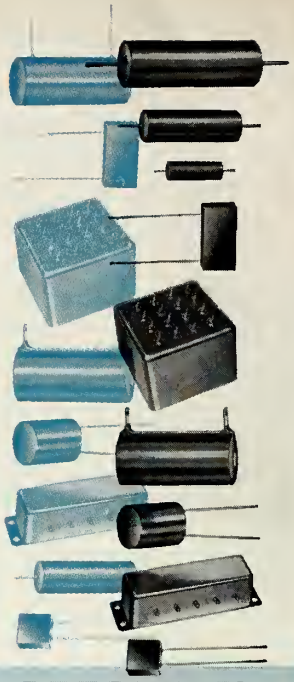
No other discriminators in these price ranges offer the performance obtainable from these models.

For additional information and specifications, write for data file MR-2443-1.

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JUNE 8, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

HOUSTON PUBLIC



IBM Checks Out Gemini Computer, OAO Data Processor

Implications of Surveyor Slippage . . . . .
Extended Apollo Proposed for MOL . . . .
STL's 'Poodle' Eyed for Saturn Use . . . . .



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TECHNICAL TALK Bulletin No. 3 discusses effects of frictional heat on tape performance as well as heavy-duty oxide and binder formulations. Free. Write 3M Magnetic Products Division, Dept. MBW-64, St. Paul 19, Minn.

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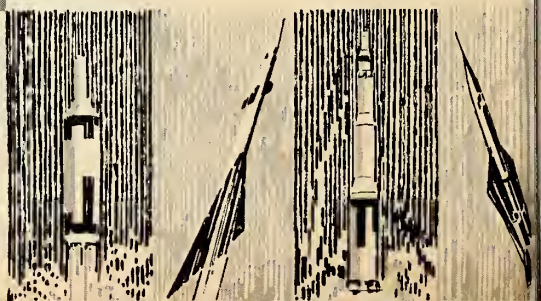
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Volume 14, Number 23 June 8, 1964

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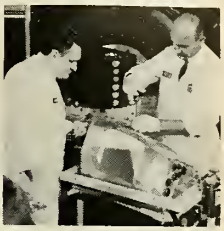
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THE COVER



First flight units of Gemini on-board computer (foreground) and Orbiting Astronomical Observatory satellite data processor (background) undergo final acceptance tests at IBM's Space Guidance Center, Owego, N. Y. Both units were accepted and shipped in the same week—the computer to McDonnell Aircraft Corp. and the data processor to Grumman Aircraft Engineering Corp.

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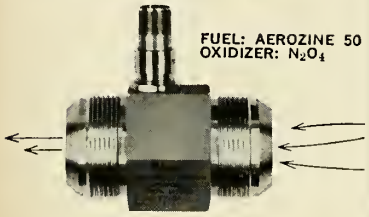
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letters

Inventor's Burdens

To the Editor:

Reference B. F. Miessner's "Creativity Penalized" letter (M/R, May 11, p. 4).

Few independent inventors can longer support the "parasites" who live off them by exorbitant patent fees. These fees are mostly for rewording of ideas, initally prepared in understandable language, into language which is not understandable and which violates every rule of correct English. Their reasons: If the description and claims are vague, it is easier to claim later that you meant something else; also, this vagueness results in more legalities and fees for the "parasites."

The Patent Office often seems aimed at destroying the inventor rather than helping him. As an example, this writer had a patent granted while traveling overseas. Because the final $25 Patent Office fee was not paid by his attorneys, and he could not be reached prior to the six-month deadline, the patent was not issued and he was told that he must start all over on it from "scratch." Eight hundred dollars and 11 years had already been spent on this application. The patent was never issued.

The plight of the creative thinker in government is well known, but not so well known is his still-more-serious plight in corporations.

The creative thinker of today seems more likely to suffer as a result of his ideas than to benefit. Creativity has been almost eliminated except in small areas. I believe this is making itself evident in the slowing advancement of this country when compared to countries which have taken stronger steps during the past 15 years to protect creativity.

Of course the Celler Bill (HR-8190) should be defeated, but this is trivial in relation to what has to be done. Creative thinkers should organize nationally before they become extinct. A strong organization could work wonders. Will some "retired" creative thinkers step forward and offer to be chairman? The rest of us are too busy scratching out a living, feeding the "parasites," or fighting the roadblocks set up in the paths of new ideas.

T. Munhall Morse
Santa Maria, Calif.

Nylon Strength and Water

To the Editor:

The Technical Countdown (M/R, April 20, p. 21) reported a decrease in nylon parachute strength of "up to 20%" on two weeks' exposure to vacuum and a recovery to within 2.3% of initial strength after seven minutes of exposure to normal temperature.

During tests I found that the impact strength of nylon specimens increased linearly with water content of the nylon. This water content can be changed easily by varying the ambient relative humidity.

While these findings do not permit conclusions to be drawn about the parachute strength variation (this is presumably tensile strength), I would suggest that water content may well be the major contributing factor in this variation of nylon parachute strength.

John G. Ruhland
Walworth, N.Y.

ASTRA's Steam Power

To the Editor:

The article "Steam Concept Interests Air Force" (M/R, April 27, p. 24) gratified us because of its accurate description of our work in space power.

In addition to ASTEC applications, it might be of interest that we have looked at a 1 emw steam space power system for electric propulsion, as well as 30-60 ekw plants applicable for communication satellites and electric propulsion testing. We have also examined the requirements for lunar base power.

For the 1 emw system for electric propulsion it was found that somewhat lighter weights, and a great deal less development cost, would result if steam were chosen. Using, for steam, an approach and conservatism similar to that taken in a recently announced study of a liquid metal powerplant for electric propulsion, 26 lb./ekw was obtained as compared with 30 lb./ekw.

The same degree of radiator segmentation and isolation was assumed for both systems; the larger area, but smaller tubes and headers for steam resulted in comparable radiator weights. Appreciable weight savings were obtained elsewhere; the water inventory, for example, would be only 230 lbs. Also, the water in parts of the cycle is cool enough to cool generators and other components.

For 30-60 ekw, steam will give lighter weights than those which have appeared in the literature for competitive systems. A steam-generating reactor or a SNAP-8 reactor could be used for the heat source. The results of a study for RCA of a powerplant for its TV Satellite System were presented in a paper by Henry Kroeger of ASTRA and Jerry Grey of Princeton at the 1963 Annual Meeting of the American Society of Mechanical Engineers.

For lunar base power it was found, on the basis of the relationship between operating temperatures and lifetimes cited in the AEC's "Evaluation of Systems for Nuclear Auxiliary Power" (TID 20079, January, 1964), that a steam system would be more reliable. It would also be lighter. Since extra water must be provided for personnel anyway, and since water is safer to work with, on-the-spot repairs would be more practical with water.

Despite what seem to us to be strong advantages in cost and performance, we're still trying to persuade people to try steam.

J. Frank Coneybear
President, ASTRA, Inc.
Raleigh, N. C.

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NEW COMPUTERS/NEW PRICES

At Eastern Joint Computer Conference 3C introduced DDP-224, faster than the DDP-24. Multi-processor options were also announced. At the same time a Van-Mounted DDP was unveiled. Prices on the 24 were reduced May 1 to reflect production economies. With this advertisement, 3C announces the DDP-24A (modified I/O capabilities) and previews the DDP-24P, portable version of the 24, small enough to pass through submarine hatches. Extensive software and user services are basic to all models. Write for complete details.



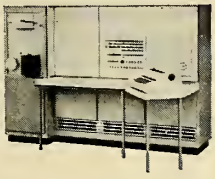
DDP-224
New 24-bit word DDP-224 features: 1.9 μsecs (0.8 access) memory cycle, and powerful command structure, 260,000 computations per second. Transfer rates up to 325,000 words per second. 3.8 μsecs add. 6.46 μsecs multiply. 17 μsecs divide. 4096-word memory expandable to 32,768. Typical add time with optional floating point hardware 7.6 μsecs (24-bit mantissa, 9-bit characteristic). Fully program compatible with DDP-24.

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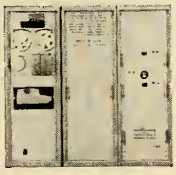
DDP-24
The DDP-24 general purpose computer with indirect addressing, hardware index register and I/O character buffer features parallel machine organization, powerful instruction repertoire, sign/magnitude arithmetic, and easy expansion. Up to 100,000 computations per second with 5 μsec access.

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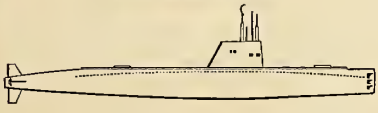
DDP-24A
A version of the standard DDP-24 which substitutes teletype paper tape and teleprinter I/O for the paper tape reader, punch, and I/O typewriter. Same mainframe features.

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DDP-24 VM
The Van Mounted DDP-24 is a rugged, compact, fully mobile general purpose digital computer; functionally identical to the 24 with paper tape reader, punch, and specially mounted I/O typewriter.

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The Portable DDP-24 is being manufactured to offer full computer capability in an ultra-compact configuration to meet demands for shipboard, airborne and other applications requiring portable computer installations.

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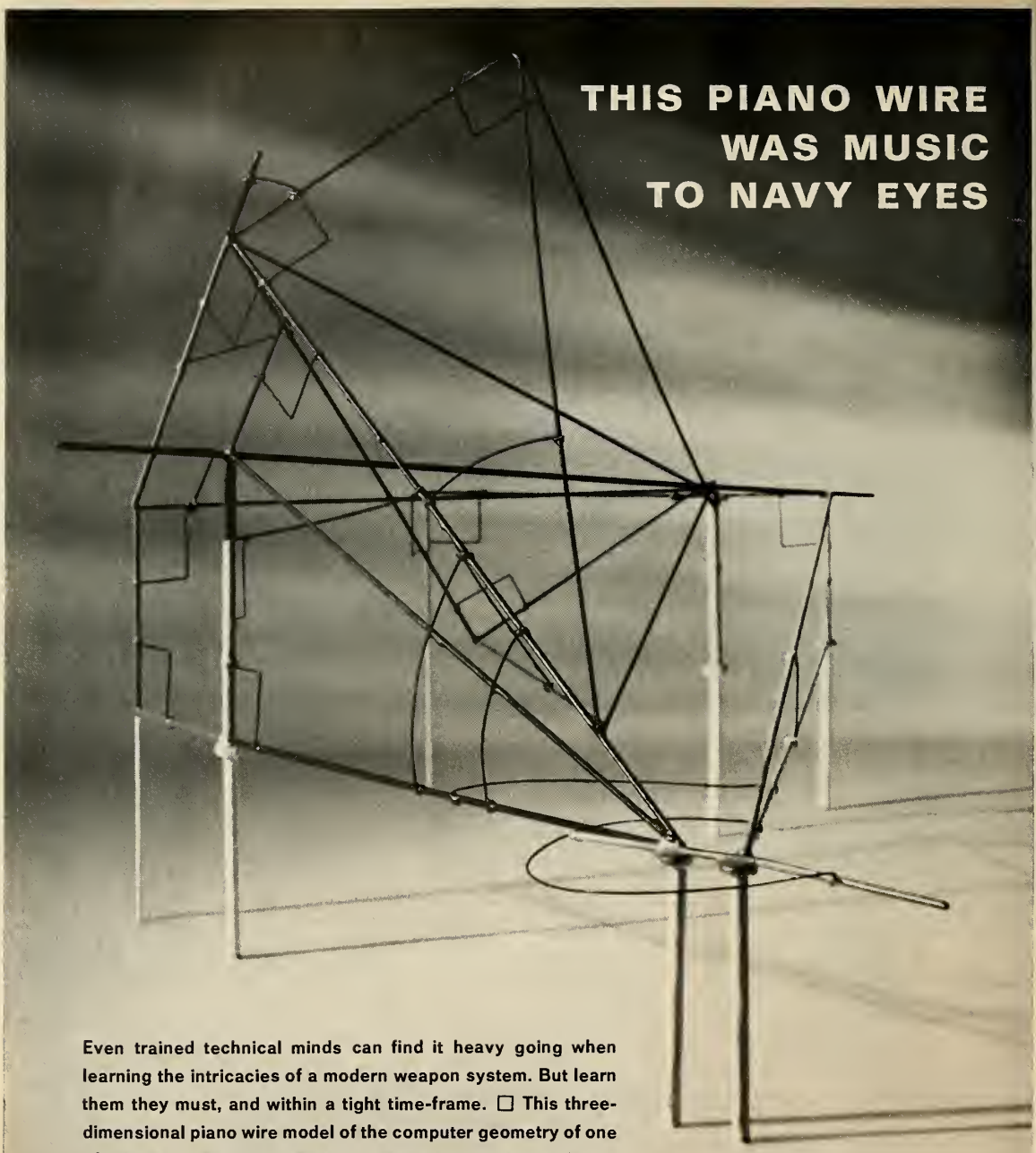
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The Countdown

WASHINGTON

Titan III-A To Arrive at Cape in July

The core vehicle for the *Titan III*—minus the troublesome Transtage—is scheduled to reach Cape Kennedy next month. It is completing sequential tests at Martin's Denver plant now. Firing is set for early September, with the firing of the first full *Titan III-C* version planned for eight months later.

ALSS Planning Picks Up Steam

Establishment of a project office for the *Apollo* Logistics Support System with the space agency's Office of Manned Space Flight sharply illustrates the growing importance of the system in the future program list. The new office will be headed by William B. Taylor. The Office of Advanced Research and Technology is also setting up a new Mission Analysis Div. to determine research that should be performed for future programs.

Air Weapons Going More Nuclear

North American Air Defense Command weapons for fighter-interceptors are being oriented more and more toward nuclear warheads. The nuclear air-to-air rocket *Genie* is an example. Philosophy of the change is that the nuclear device gives greater assurance of total systems kill—that is, not only the bomber but the nuclear weapon it carries.

MLF Ships Could Carry More Missiles

Ships being designed for implementation of the Multilateral Force will carry eight *Polaris* missiles. However, the design is such that this number could be expanded four-fold, to 32 missiles, if one or more of the NATO countries thought it worthwhile.

Over-Horizon Doesn't Negate MIDAS . . .

In the opinion of one NORAD general, the development of over-the-horizon radars doesn't eliminate his command's requirement for a *MIDAS*-type system. In spite of what he terms "the unbounded potential" of the radar "to give us a look at an enemy's airfields and launch pads," he feels that *MIDAS* would provide a valuable complement and should be developed. DDR&E, however, has different feelings on the subject.

. . . Which Is Going Piggyback

Extent of the re-orientation of the *MIDAS* program became evident when a DOD official announced that during FY '65 the missile defense system would be limited to piggyback launches on other Air Force missions. In addition, only about $30 million is allotted in the budget to carry on *MIDAS* technology.

Economy Guidance Package Slipping

Navy plans to test three low-cost guidance packages on *Sergeant* missiles this summer are likely to slip considerably beyond that, says an official who has been closely involved with the program. Delivery schedules for the guidance units —designed for the Navy Close Support Missile—are completely unrealistic, he declares, and the $10,000 unit cost the Navy is seeking for production units is likely to be at least doubled.

Morrison Rumored Leaving NASA

There are reports that Dr. Richard Morrison, director of launch vehicles in the Office of Space Sciences and Applications, is leaving the space agency to return to teaching. Date for his resignation is said to be July 15. In the interval, he is making a study of future launch vehicle requirements.

Meteoroid Package Set for WSMR Firing

A meteoroid detection payload is scheduled for launch aboard an *Aerobee* rocket at White Sands Missile Range (N.M.) this week. A 14-ft. paraglider device will be used to return the detector to Earth from its peak altitude of 120 mi.

INDUSTRY

Titan III Half-Year Plans Laid

Air Force Space Systems Div. met with contractors late last week to discuss what will be done in the *Titan III* booster program during the next six months. Talks included impending plans for *Titan III-A* rollout, installation in its facility, and first *Titan III-A* launch.

Control Data Building Apollo Checkout Gear

Control Data Corp. has been awarded a $13.7-million contract to provide 10 automatic checkout equipment stations for the *Apollo* spacecraft program. One will be used at Cape Kennedy, one at Manned Spacecraft Center, and eight by other contractors in the program.

Heavy Bidding on Houston Support Contract

Fourteen firms have submitted bids for an operational support services contract at the Manned Spacecraft Center. Technical proposals are due June 8 and cost proposals June 15. Contractor will be chosen in July.

Deep-Space Satellite Study Award Nearing

NASA is to announce on June 29 its choice of a contractor to study a deep-space micrometeoroid satellite. Study calls for preliminary design of a satellite to be launched by one of the agency's existing launch vehicles. Bidders include Bendix Corp., Boeing Co., Fairchild Stratos Corp., General Electric Co., Ling-Temco-Vought, Inc., Martin Co., Philco Corp., and Thompson Ramo Wooldridge, Inc.

INTERNATIONAL

French Accent Tactical Missilery

Re-equipment plans of France's army cover development of an arsenal of tactical missiles including: *Ground-to-Air* —Nord Aviation (SABA and Franco-German *Roland* studies) working on a light weapon to compete with Matra-EMD and SHORT (*Aramis*). *Roland* has reached testing stage; *Ground-to-Ground*—Sud-Aviation (*Pluton* and *Vland* projects) and Nord-Aviation are developing a 30-mi.-range, AMX-carried *Honest John*, and Matra and EMD are working on comparable missiles of which no details are known; *Antitank*—Nord-Aviation has three projects going: *HOT*, *ACRA*, and *Milan* (reported similar to U.S.-made *TOW*). At least two of the antitank studies are being made in conjunction with Germany's Bölkow. The Arsenal of St. Etienne will also develop small antitank and air-defense missiles.

SA-6 Boosts Dummy Apollo

The space agency has chalked up the first major flight test in Project *Apollo* with the successful orbiting of the first boilerplate spacecraft.

The launch with the *Saturn I* booster was made from Cape Kennedy at 12:08 EST, May 28. The *SA-6* payload—consisting of the boilerplate *Apollo* and the booster's S-IV second stage—re-entered the atmosphere and disintegrated over the western Pacific during its 50th orbit of the Earth.

Officials immediately announced that another launch with a similar payload will be made in the August-September, 1964, period.

One of the highlights of the *SA-6* mission was the operation of the ST-124 guidance platform, which controlled the second stage during flight.

Dr. Wernher von Braun, director of Marshall Space Flight Center, declared that it worked perfectly. Plans now call for its use for complete booster guidance in the *SA-7* mission.

There was one small malfunction during the flight. One of the eight H-1 engines in the first stage shut down 24 seconds early. Deviation of the planned trajectory caused by the engine-out was corrected by the *SA-6* guidance system and performance of the vehicle was close to nominal. Cause of the premature shutdown is still being investigated.

Two other problems were encountered in the ground support equipment. The launch was originally scheduled for May 26, but it was delayed for two days when a compressor feeding nitrogen gas to cool the guidance system malfunctioned.

On May 28, the flight was delayed for a short period when an "annin" liquid oxygen replenishing valve froze.

Orbital parameters for the *SA-6* flight were: apogee, 140.4 mi.; perigee, 123.9 mi.; period, 88.5 min.; and inclination, 31.8 degrees.

GAO Assails Expenditures

The General Accounting Office last week charged Jet Propulsion Laboratory and Lockheed Missiles & Space Co. with excessive and unnecessary expenditures of Government funds. At the same time, GAO urged the Air Force to take "aggressive action" against the Boeing Co. to recover an alleged $23-million overcharge in the *Bomarc A* missile program.

In a report to Congress, the office claimed that JPL unnecessarily spent over $3.2 million for computer rentals without giving adequate consideration to purchase of the equipment.

Lockheed was charged with excessive contract costs of $101,200 through a company employee relocation policy. The report said that the Lockheed practice of paying transferred employees a daily relocation allowance extends for "a period greatly in excess of the period actually needed to establish a new residence."

In the report on Boeing's *Bomarc* program, which consolidated a number of previous reports on the subject, GAO said that overstated initial target cost estimates for two contracts negotiated in 1958 and 1959 resulted in a program overcharge of $23 million, about $2.3 million of which was company profit. The report urged that immediate steps be taken, in coordination with the Justice Dept., to obtain full recovery of the alleged overcharges.

Shots of the Week

Despite premature shutoff of one of its eight 188,000-lb.-thrust H-1 engines, NASA's *Saturn SA-6* shot put into orbit the first boilerplate *Apollo* spacecraft on May 28. The launch was made from Cape Kennedy (see story above).

- The Air Force destroyed an *Athena* missile some 70 seconds after launch from Green River, Utah, on May 28 when "it appeared to be progressing out of the flight corridor." However, the possibility emerged after the shot that tracking data that prompted the abort was incomplete and could have led to a wrong decision.

ComSat Stock Sale Begun

Public sale of 5 million shares of Communications Satellite Corp. stock began June 2 and pushed the price up $7 per share within the first hour of trading before settling at around $23 per share.

Most of the 11 managing underwriters were forced to limit sales to 10 shares per customer in order to meet public demand. The stock was offered June 2 at an initial price of $20 per share.

Sale of the 5 million shares reserved for communications carriers closed late last month with American Telephone & Telegraph Co. receiving approximately 2,895,000 shares. Next on the list of 163 buyers were ITT with 1,050,000 shares; General Telephone & Electronics Corp., 350,000 shares; RCA Communications, Inc., 250,000 shares, and other authorized carriers, 454,250 shares.

GOP Group Hits Apollo Goal

The Republican Citizens Committee's Critical Issues Council has urged abandonment of the 1970 *Apollo* lunar landing goal and introduced a five-point program that they claim would be "sounder" and would require "annual expenditure rates lower than those now committed or proposed."

Based on the premise that total expenditures would be cut back, the group, headed by Dr. Milton Eisenhower, urged adoption of five major rules for the U.S. space exploration effort:

—Continue development of launch vehicle systems to the extent needed to meet revised objectives.

—Require detailed instrumented exploration of the lunar surface prior to any landing.

—Allow time for sufficient study of the space and lunar environment to permit manned flights to the vicinity of the Moon with confidence in their safety.

—Conduct further negotiations with other nations for cooperative space exploration.

—Assure collaboration between the civil and military programs in the use of manned orbiting laboratories in an exhaustive effort to study the capabilities of man in space.

NASA Awards Total $356M

The space agency has announced three new contracting actions with General Dynamics/Astronautics, Douglas Aircraft Corp. and RCA's Astro Electronics Div.

NASA and GDA signed a $237-million contract for a total of 14 *Centaur* flight stages.

The award to Douglas is for an estimated $110 million. It covers the purchase of eight additional S-IVB stages for the *Saturn IB* launch vehicle.

The RCA division was selected to manufacture five *Tiros* operational weather satellites. The contract is expected to exceed $9 million.

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Surveyor Slippage Indicated

First flight, set for late this year, now delayed until second quarter of 1965; first TV pictures expected in mid-1966

by Hal Taylor

THE *SURVEYOR* lunar soft-landing spacecraft now is not expected to take television pictures of the Moon until mid-1966.

This means that Project *Apollo* engineers will have to rely on three upcoming *Ranger* spacecraft missions for details of the lunar surface for a period up to three years before the actual manned lunar landing missions.

The slippage in the *Surveyor* program was revealed as space agency officials disclosed that the first flight of the 2,150-lb. spacecraft will be delayed until the second quarter of 1965. It had originally been scheduled for late this year.

After the first flight, space agency plans call for two more engineering flight tests in the third and fourth quarters of next year. A final test flight would be made early in 1966; then the first of three operational unmanned lunar landing missions—all scheduled for 1966—would be attempted.

The problems inherent in such a tight flight schedule, however, are compounded by the fact that the timetable leading up to the first *Surveyor* flight optimistically calls for five straight successful *Atlas-Centaur* launches in a 12-month period beginning this month.

This is the fastest firing rate ever attempted in the U.S. space program.

It pins its hopes on the trouble-plagued *Centaur* liquid hydrogen upper stage, which is more than two years behind schedule. Some six months have separated the successful *Atlas-Centaur 2* launch in November, 1963, and the *AC-3* flight slated for this month.

If, in addition to the tight lanch schedule, the usual technical problems that have cropped up in similar space programs hit *Surveyor,* the spacecraft conceivably may not make its first touchdown on the Moon until 1967.

● **Earlier pictures?**—NASA officials, however, have revealed that there is one possibility of dispelling the pessimistic outlook. If one of the first four flights moves successfully through the planned 66-hr. mission, an attempt may be made to activate the TV cameras and take pictures of the lunar surface.

They admit that the primary objective of these first flights is engineering evaluation of the spacecraft subsystems. While they will carry two TV cameras, the first four spacecraft have been stripped of scientific experiments so that engineering test equipment can be carried.

At the same time, they concede that there has been some pressure within the agency—probably from manned space-flight officials—to change the primary objective of some of the first four flights from engineering test to an attempt to take TV pictures of the Moon. So far this has been resisted by space science officials.

● **On to Block II**—The approved *Surveyor* program now calls for 17 flight spacecraft.

The experiments will include a surface sampler which will pick up pieces of the surface and transmit data on its composition. Other tests include an alpha scattering experiment, a micrometeoroid detector, a single-axis seismometer and a touchdown dynamics experiment.

Space agency officials are also ready to move ahead with the so-called heavy *Surveyor* spacecraft, which will weigh from 2,500 to 2,800 lbs.

This is scheduled for 10 flights beginning in 1967. Its primary mission will be selection of a lunar landing site for U.S. astronauts and continued exploration of the Moon's surface. These Block II *Surveyors* are expected to carry a roving vehicle that will move over the surface while controlled from Earth.

Two engineering test models—developed by General Motors and Bendix Corp.—are currently being evaluated by the space agency. One of the firms is expected to be selected within the next few months for a prime contract to build the vehicles. It is expected that the vehicle will weigh from 125 to 140 lbs. and will have an operating radius of one to two miles. ■

Floxed Atlas Awaits Seamans' Okay

DR. ROBERT C. SEAMANS, NASA associate administrator, is expected to make a decision in the near future on the floxed *Atlas* program.

The project, which would add fluorine to the booster's liquid oxygen supply, is expected to increase its payload capability by some 30%.

NASA officials reported that the program laid before Seamans called for the use of two *Atlas* boosters left over from Project *Mercury* to be used as ground test vehicles. In addition, two other flight-configuration *Atlases* would be purchased for a flight-test program beginning in late 1966 and lasting into 1967.

If approved, the first payload for the booster would be the heavy *Surveyor* spacecraft—scheduled for launching in 1967—with a total of 10 flights on tap.

While the House and Senate space committees have both approved the space agency's request for Fiscal '65 funds for the program, informed sources report that the high cost of building facilities for the project is hurting its chances of getting Seamans' okay.

They indicated that if new facilities are required to test for floxed *Atlas,* the total cost could reach $100 million.

As a result, it is reported that DOD and some NASA officials are contending that since the Air Force's *Titan III* booster will be available in the same time period, a switch to that vehicle may save money.

NASA officials reported that a decision—with the floxed *Atlas* well ahead at this point—may be made in the next few months.

Crucial Booster Hearings Start Soon

Senate committee calling on Webb, McNamara to lead testimony; highlights of group's action on FY 1965 space agency budget

by Heather M. David

THE SENATE Aeronautics and Space Sciences Committee has tentatively set June 17 and 18 for initiating its investigation of the nation's booster programs.

Committee sources report that the group, headed by Sen. Clinton P. Anderson (D-N.M.), will review all boosters being produced or planned by both NASA and the Dept. of Defense, then make recommendations as to which programs should be pursued—and which should be cancelled.

The results of this study may be the most meaningful yet in the history of the space program. Six members of the Senate Aeronautics and Space Sciences Committee also hold top positions on the Senate Armed Services Committee; one of them—Sen. Richard B. Russell (D-Ga.)—is chairman of that group. Five wield powerful votes in the Senate Appropriations Committee; they include Russell, chairman of the Defense Appropriations Subcommittee, and Sen. Warren G. Magnuson (D-Wash.), chairman of the Independent Offices Subcommittee. Thus, the decisions of the Senate Space Committee probably will be translated into direct fiscal fact.

● **Heads lead**—Both NASA Administrator James E. Webb and Secretary of Defense Robert S. McNamara have been asked to appear, each with a supporting cast that will provide the committee information on booster characteristics, research and production costs, weights and other factors. The committee will also ask for a complete technical evaluation of each booster used for any space purpose, and finally a breakdown of dollars per-pound-in-orbit.

The committee hopes that the probe will have three beneficial results:

—The agencies will agree to produce only one family or stable of boosters, smaller in number and therefore more economical.

—Since there will be more shots per booster, a higher degree of reliability will be achieved.

—The "marginal" boosters, which perhaps are produced at the rate of only three or four a year, will be knocked out.

● **Reassurance**—Although some industry observers have voiced their apprehension about the investigation, which presumably could lose some business for a few companies, committee spokesmen say they feel that industry will be better off in the long run. They explain that the kinds of programs the committee would recommend dropping would be those in which boosters are produced in such small numbers that they provide no profit to the companies involved, and cannot be sold in competition with the bigger programs.

The group indicated that it would not attempt to pit liquid boosters against solids *per se*, since it feels that solids have yet to be tested enough to show their capabilities.

The committee recognizes that reducing the variety of boosters in the national repertory may mean that there will never be a perfect launch vehicle for each launching mission, but it nonetheless feels that costs per-pound-in-orbit are more important.

The announcement culminates a long drive by members of both Houses to achieve unification in the booster program (M/R, March 28, p. 13). The Air Force and NASA have made some moves toward agreement on such a program (M/R, May 11, p. 14).

● **Big solids**—In reporting its action on the FY 1965 authorization of the NASA budget, the Senate Space Committee also asked NASA to decide by March 15, 1965, whether it will proceed with Phase II of the big solid booster program.

In other actions on propulsion, the Senate upheld the gratuitous House increase of $4 million for advanced liquid and large solid propellant study, but deleted the House-imposed division of this total into $3 million for liquids and $1 million for solids.

The committee once again cautioned NASA on the SNAP (Systems for Nuclear Auxiliary Power) program. It recommended steps to insure that the program doesn't end up by the wayside before flight-testing because the agency suddenly declares there is no mission for it.

● **Probe warning**—The Senate committee voiced "reservations" about NASA's lunar and planetary probe program, on the basis that "some of the planned missions might develop unneeded information." By 1966, the group indicated, sufficient data might be available to make it possible to adopt a more economical program. Thus, it has instructed NASA to present a firm program to this end in FY 1966 authorization hearings.

However, the committee did restore $12.3 million cut by the House from *Surveyor,* and $6.5 million trimmed from the *Orbiting Geophysical Observatory.*

● **Manned spaceflight**—All manned spaceflight money was approved by the Senate committee as requested by the agency, including $3.9 million of a $26-million fund for advanced missions, which had been deleted by the House.

In the only new cut in the budget, the Senate committee pared $6 million from the $46 million requested for the sustaining university program. The House had approved the request in full.

As did the House, the Senate approved a $7-million cut in the *Orbiting Astronomical Observatories,* on the basis that the spacecraft affected will not be launched until 1958 or 1959; a $2.5-million cut in *Orbiting Solar Observatories,* because it felt NASA does not need more than one *OSO* in orbit at one time; a $1.2-million fund sought for studies on economic considerations affecting communications satellites; and a number of token cuts in Advanced Research and Technology programs.

● **Construction**—The Senate modified the 10% across-the-board slash imposed by the House on Manned Spaceflight Center construction, calling instead for a reduction of only 5%. It also brought the $23-million cut in the $641-million request for administrative operations down to $11.7 million. ■

NASA/Industry Team Wants Future Manned Flights To Use Apollo Core

Four configurations proposed for Extended Apollo spacecraft would permit missions ranging from 30 days to a Mars fly-by

by James Trainor

AN *APOLLO* Derivatives Development Plan proposes to use the lunar landing program hardware as the nucleas for future manned space flight programs—including the Air Force's *Manned Orbiting Laboratory* (*MOL*), as well as space stations and lunar base and resupply missions.

Developed by the *Apollo* NASA/industry team, the plan reportedly estimates that an *Extended Apollo* could provide five or six *MOL* vehicles for one-third to two-thirds the projected $1-billion cost of the AF program.

The most cost/effective approach to the *MOL* requirement would use *Saturn IB* as the launch vehicle. Realizing that *MOL* so far is the only mission for the $800 million *Titan III*, however, the plan also proposes that the *Apollo* Command Module be substituted for the *Gemini B* in the present *MOL* configuration, and the *Titan III-C* be used to launch the *MOL*.

In addition to providing "justification" for *Titan III*, this combination could put three men in orbit for 30 days—the third man, the argument runs, being provided "free." The Command Module would be "hammerheaded" to the smaller-diameter *MOL* for the mission.

● **Four configurations**—Four versions of the *Extended Apollo* concept, all of which use the Command Module, the Service Module and the Lunar Excursion Module adapter section, are presented in the Derivatives plan. These alternatives are numbered 0 through III.

The 0 configuration is *Apollo-X*, which would place two men in orbit for 30-90 days. Only the Command Module would be pressurized, but experiments could be carried in the unpressurized portions with readout in the Command Module. The vehicle would use the same hardware systems employed in *Apollo*.

The I configuration would replace *Apollo* subsystems with more advanced hardware and would use solar cell panels on the Service Module to achieve longer stay-time in orbit.

In the II configuration, a three-deck, fully pressurized laboratory with 5,600 cu. ft. internal volume would be provided in the LEM adapter section. The Command Module would be turned around and docked to the adapter section. This version could carry three to six men for extended missions.

Configuration III would be similar to II but would provide additional subsystems to make the vehicle more self-sufficient and permit it to make a Mars fly-by.

One of the arguments for *Extended Apollo* is that 30 days in orbit, as visualized in the *MOL*, is not long enough to properly investigate the zero-g effect on man for the interplanetary missions NASA has in mind. Lengthening the

DOD Space Spending—FY '65

First unclassified breakdown of Defense Department space spending for Fiscal Year 1965, as well as for the previous four budget cycles, is shown below. This chart, however, does not give the total DOD spending for space because some funds have been earmarked for classified programs.

Manned space flight—principally *MOL*—is budgeted at $81.0 million, which will allow full-scale development of the laboratory to begin in the next spending year. Except for general support, which includes in-house programs, development support organizations and military construction not charged against other space programs, all areas of the space budget show a decrease from FY '64 levels.

DOD SPACE AND SPACE-RELATED PROGRAMS
(in millions of dollars)

	1961	1962	1963	1964	1965
Manned space flight	58.0	100.0	133.2	93.6	81.0
Communications	55.2	104.6	59.6	78.8	49.3
Navigation	23.6	22.0	42.1	27.9	24.8
Detection and early warning	122.5	180.8	102.5	61.9	34.6
Space defense	8.2	33.0	45.9	62.7	24.9
Vehicle and engine development	3.7	68.3	308.2	384.5	282.0
Space ground support	57.8	102.6	166.3	168.1	196.8
Supporting research and development	74.2	155.7	147.3	159.6	158.0
General support	420.7	531.2	574.2	578.7	622.7
TOTAL	813.9	1,298.2	1,579.3	1,615.8	1,474.1

stay-time in orbit is a strong argument in the cost/effectiveness analysis, since the major costs in a space station program such as *MOL* are the number of launches in the program.

Even with a resupply or ferry vehicle, the principal costs—once the *MOL* development cost is amortized—would be in these portions of the mission profile. In the opinion of Air Force officials, however, this argument for a larger, longer stay-time *MOL* is not critical because military investigations of space could require a number of trips between Earth and *MOL* independent of resupply and crew rotation needs.

● **MOL status**—Difficulties in defining the scope of the *Orbiting Space Station* (*OSS*) studies delayed signing of the four-month contracts until last week. These studies—to be conducted by Douglas Aircraft Co., General Electric Co. and the Martin Co.—are expected to provide *MOL's* experimental basis.

When the studies are submitted to the Air Force Systems Command's Space Systems Div. in October, a month's evaluation is expected before the Air Force goes out on an industry-wide competition for the *MOL*.

Development of the system is expected to begin six months later and require 24-30 months. This schedule, according to Brig. Gen. Joseph S. Bleymaier, SSD's deputy commander for manned space systems, would mean the first *MOL* would fly in 1967 or early 1968.

● **Funding**—DOD released $6 million May 20 for the Pre-Phase I portion of the program. This will cover not only the *OSS* studies but several complementary investigations of specific *MOL* subsystems. First of these subsystem studies was put out for bid to AiResearch Div. of the Garrett Corp. and the Hamilton Standard Div. of United Aircraft for a study of the *MOL* environmental control system.

Requests for proposals have also gone to a dozen companies for evaluations of alternative electrical power subsystems, including fuel cells, solar arrays and batteries.

A third area that may be submitted to industry for study, Bleymaier says, is the attitude control subsystem. These are 105-day, fixed-price contracts.

SSD expects to have responses from Martin Co. and McDonnell Aircraft Co. "in a matter of days" on what is required to modify *Titan III* and *Gemini* for use in the *MOL* program. The *MOL* itself, Bleymaier has said, would weigh 8,000 lbs. without the experiments or support equipment.

● **Missions for MOL**—Critical to *MOL* development is the design of experiments that truly test man's ability to perform useful military functions in space. SSD, therefore, is seeking to make a strong case for experimentation in those areas that are "not common" to the civilian space program and are "most credible." Primary among these missions is observation such as that now performed by *SAMOS* satellites and envisioned in *MIDAS* payloads. Other missions under consideration by SSD include:

—interception and inspection of potentially hostile satellites;

—achievement of maneuverability not essential to scientific operations both in orbit and during re-entry;

—determination of weapons effects on space vehicles;

—achievement of quick, unforeseen reactions not necessary in scientific missions;

—investigation of missile signatures from space and determination of whether a manned system could contribute to solution of the problem of defense against ICBMs;

—determination of whether a manned system could perform certain offensive missions against ground-based installations.

● **Top echelons optimistic**—Until experiments to implement these missions and man's role in them are designed, however, ground- and aircraft-tested and finally tested-in-orbit, operational equipment cannot be designed for manned spacecraft.

It is this insistence on detailed design and test of *MOL* experiments that has discouraged *MOL* advocates both in Air Force field installations and in industry. But there is a conviction in higher Air Force echelons—reinforced by a marked change in DOD's attitude—that *MOL* will become a going program and will prove man's utility in space.

The slow pace of the program, one official explains, can be attributed to the fact that adherence to the rigid schedule as in an operational systems development is not a dominant factor. Rather, attainment of program objectives, particularly the experimental objectives, is the pacing factor. Air Force officials frankly deplore the cynicism of their field counterparts in dismissing *MOL* as a "political" move and a program unlikely to reach fruition. ■

K's Statement Sticky for Pentagon

SOVIET PREMIER Khrushchev's assertion that Russian satellites have photographed American military bases has put Pentagon officials in an embarrassing position. They refuse even to acknowledge the existence of a U.S. reconnaissance satellite program, but they are ready to assure MISSILES AND ROCKETS that U.S. capabilities in this area are probably more comprehensive and more effective than anything the Soviets might be able to do.

Since the veil of secrecy was dropped over even the name *SAMOS* in 1961, U.S. efforts in the use of space photography for reconnaissance have been credited with dispelling the illusion of a "missile gap" and with convincing U.S. planners that the large, vulnerable first-strike type of ICBM force the Soviets were building was being converted to a hardened second strike, *Minuteman*-type strategic force.

Resolution of the *SAMOS* satellite photographic equipment has been continuously improved through use of longer focal length cameras and higher emulsion photographic film.

Khrushchev's statement was made in an interview with William B. Benton, chairman of the board of Encyclopedia Britannica. According to Benton, the Russian leader told him that satellite reconnaissance could be used to replace aircraft overflights of Cuba. The Soviet Premier also offered jokingly to "exchange" photos with President Johnson. Last July, Khrushchev also offered to let Belgian Foreign Minister Paul Henri Spaak "see my photographs."

Main reasons for the continuing U.S. insistence on denying even the existence of the *SAMOS* program are international reaction and military capability.

The first, according to DOD spokesmen, is the primary. The U.S. is afraid to evoke spy charges in the United Nations over the open use of *SAMOS*. The Soviets have attacked the program in the past, they admit, but these attacks would pale before the recriminations of the Russians if *SAMOS* were an open program.

The second reason is that some military men feel that by conducting *SAMOS* as an open program, too much would be revealed about the value of space reconnaissance as well as the limitations of the technique.

Although several searching reviews of the military space classification policy have been conducted, these Pentagon officials say, there have been "darned few" changes in the basic policy to conduct military space operations in secret.

Space Agency Procurement Up 48%

SPACE AGENCY procurement spending in the first six months of Fiscal Year 1964 totaled $1.939 billion, 48% ahead of outlays in the same period of the previous fiscal year.

About 76% of the total was placed directly with business firms, 2% with educational institutions, 7% with Jet Propulsion Laboratory and 15% with other government agencies.

Contracting by the last three groups with industry brought the total spending with business to 95%, the space agency said.

Approximately $1.167 billion, or 83% of the total, was placed under cost-plus-fixed-fee contracts. As part of the trend toward incentive-type contracts, the space agency awarded seven new contracts which include incentive provisions and converted three other contracts to the comparatively new contract form.

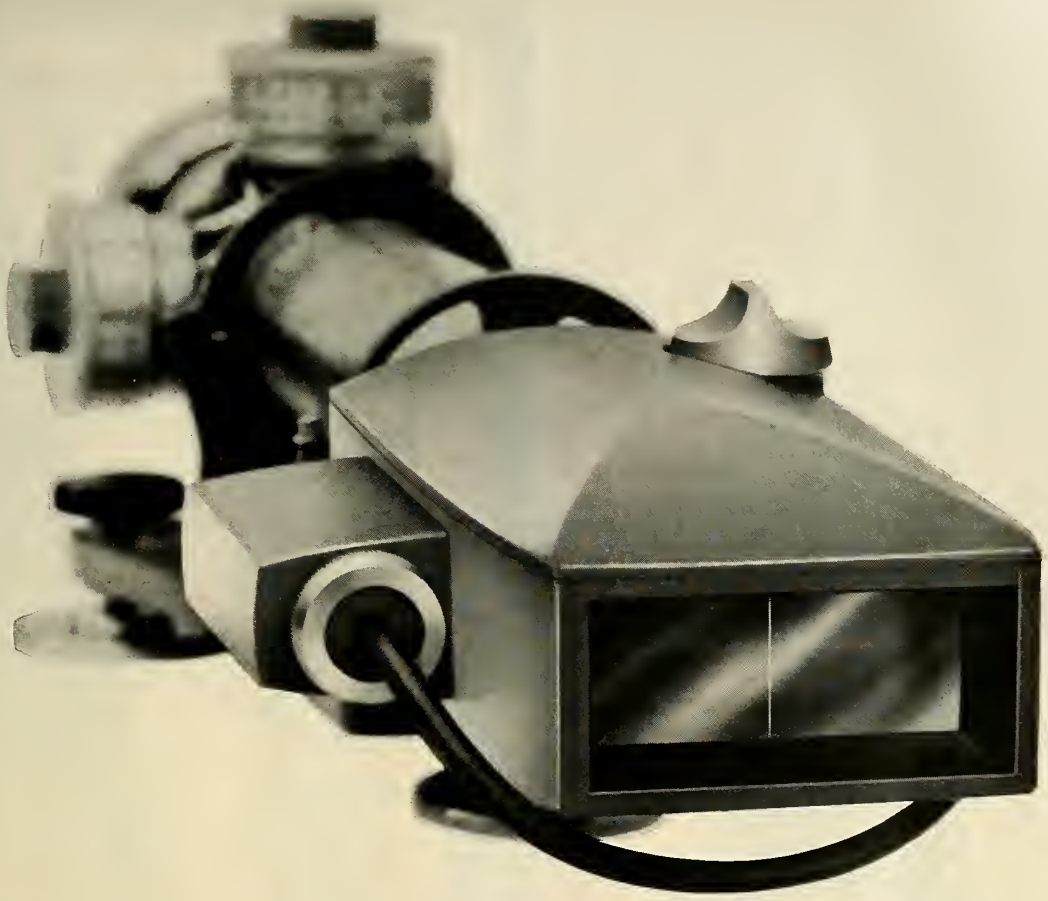
Profit fees on the cost-plus-fixed-fee awards averaged 5.68% with a range on individual contracts running from 3.8 to 9.43%. This marked a drop from the 6.38% profit range chalked up by contractors in the same period of Fiscal '63.

Holding the top 10 spots on NASA's contracting list, based on geographical location, with figures denoting millions of dollars, were: California 717; Missouri, 139; Louisiana, 139; New York 84; Florida, 78; Alabama, 63; Massachusetts, 29; Texas, 27; Maryland, 26; and the District of Columbia, 24.

Small-business participation totaled $94 million, 31% above the previous period. In terms of total awards to business, small-business participation dropped from 9 to 6% in the first half of FY '64. ■

TOP FIFTY NASA CONTRACTORS—FIRST HALF FY 1964

	CONTRACTOR	RANK JUL-DEC 1962	THOUSANDS OF DOLLARS
	TOTAL AWARDS TO BUSINESS		$1,464,401
1.	North American Aviation, Inc.	1	422,958
2.	McDonnell Aircraft Corp.	2	138,872
3.	Douglas Aircraft Co., Inc.	7	94,860
4.	General Dynamics Corp.	4	75,665
5.	Boeing Co.	6	72,715
6.	Grumman Aircraft Engineering Corp.	11	60,378
7.	Chrysler Corp.	5	55,893
8.	Aerojet-General Corp.	3	54,795
9.	General Electric Co.	13	42,760
10.	International Business Machines Corp.	10	26,547
11.	Radio Corporation of America	9	20,685
12.	Brown Engineering Co.	17	18,943
13.	United Aircraft Corp.	8	17,809
14.	Bendix Corp.	15	17,184
15.	General Motors Corp.	23	15,933
16.	Space Technology Laboratories, Inc.	12	14,659
17.	Hayes International Corp.	20	13,280
18.	Lockheed Aircraft Corp.	21	12,417
19.	Ingalls Iron Works	***	11,225
20.	Ernst/Smith Joint Venture	***	9,847
21.	Bellcom, Inc.	35	8,851
22.	Raytheon Co.	48	8,827
23.	Philco Corp.	40	7,112
24.	Jones J A Construction Co.	***	6,391
25.	Kollsman Instrument Corp.	32	6,357
26.	Radiation Inc.	59	6,225
27.	Ling-Temco-Vought, Inc.	16	5,367
28.	Mason-Rust	14	5,341
29.	Union Carbide Corp.	22	5,287
30.	Fairchild Stratos Corp.	38	5,219
31.	Hughes Aircraft Co.	18	4,575
32.	American Telephone & Telegraph Co.	45	4,499
33.	Federal-Mogul-Bower Bearings, Inc.	94	3,848
34.	Collins Radio Co.	28	3,641
35.	Basic Construction Co.	***	3,095
36.	Sperry Rand Corp.	41	3,041
37.	Space Inc.	44	2,897
38.	Republic Aviation Corp.	19	2,812
39.	Martin Marietta Corp.	31	2,464
40.	Electro-Mechanical Research Inc.	26	2,425
41.	Sullivan Long & Hagerty	33	2,235
42.	Northrop Corp.	***	2,014
43.	Avco Corp.	***	1,889
44.	Air Products & Chemicals, Inc.	***	1,723
45.	Control Data Corp.	50	1,698
46.	Schrimsher J. T. Construction Co.	51	1,676
47.	Management Services Inc.	65	1,622
48.	Bechtel Corp.	***	1,596
49.	Consolidated Electrodynamics Corp.	56	1,485
50.	Pearce & Gresham Co.	***	1,451
51.	Space-General Corp.	***	1,368
52.	Bell Aerospace Corp.	***	1,278
53.	Minneapolis-Honeywell Regulator Co.	81	1,233
54.	American Machine & Foundry Co.	66	1,200
55.	Thompson Ramo Wooldridge, Inc.	53	1,188
56.	Wyle Laboratories	***	1,135
57.	Chicago Bridge & Iron Co.	***	1,123
58.	Westinghouse Electric Corp.	88	1,093
59.	Educational Services	63	1,066
60.	Lear-Siegler, Inc.	***	1,063
61.	Aero Space Lines Inc.	***	1,044
62.	Garrett Corporation, The	86	1,043
63.	Conoco Electronics Corp.	***	1,034
64.	Schjeldahl G T Co.	93	1,012
65.	Radiation Service Co.	***	893
66.	C&B Construction Co.	***	878
67.	Zia Company	***	875
68.	Ryan Aeronautical Co.	68	868
69.	C & P Telephone Co.	54	859
70.	Thiokol Chemical Corp.	96	841
71.	Computer Application Inc.	***	824
72.	Geophysics Corp America	75	820
73.	Calumet & Hecla Inc.	39	815
74.	Ampex Corp.	30	809
75.	Motorola Inc.	67	779
76.	Associated Builders Corp.	***	767
77.	Graham Wm J & Son	***	752
78.	Vitro Corporation of America	42	741
79.	Int'l Telephone & Telegraph Corp.	73	730
80.	Kane Transfer Co.	***	715
81.	Arinc Research Corp.	***	695
82.	Packard-Bell Electronics Corp.	27	688
83.	Cleveland Electric Illuminating	***	679
84.	Xerox Corp.	92	677
85.	Southwestern Bell Telephone Co.	***	651
86.	Ball Brothers Research Corp.	***	641
87.	Potomac Electric Power Co.	***	613
88.	Scientific Data Systems	77	607
89.	Textron Electronics Inc.	***	596
90.	Atkins & Merrill, Inc.	***	554
91.	Goodyear Aerospace Corp.	100	547
92.	American Optical Co.	***	510
93.	Watland Inc.	95	493
94.	Aero-Geo-Astro Corp.	***	486
95.	Redstone Machine & Tool Corp.	90	483
96.	Continental Graphics Inc.	***	471
97.	Rantec Corp.	***	450
98.	Progressive Welder Machine Co.	91	445
99.	Marbury-Pottillo Construction Co., Inc.	55	434
100.	Adler Electronics, Inc.	***	421



New angle-measuring interferometer

Kollmorgen Model K-421 brings 0.02 second-of-arc sensitivity out of the laboratory into practical engineering use.

Uniquely simple! Unlike conventional interferometers, portable Model 421 Pointing Interferometer has a single optical element . . . a special Koesters double-image prism having equal internal paths. Permanent calibration is inherent. Minimum operator training is required.

How it works! The four-pound Model K-421 is designed to mount on an alignment telescope having an NAS 2.25-inch diameter barrel. Two parallel beams of light are projected at a plane mirror. Mirror rotation changes the path lengths of the reflected beams and establishes an interference fringe pattern.

Highly sensitive! Model K-421 is so calibrated that one interference fringe represents a mirror rotation of one second of arc. With the optical micrometer on the Kollmorgen K-122 alignment telescope, you can subdivide each fringe into increments as small as 0.02 second of arc. With the Model K-120 Line-of-Sight Alignment Telescope, visual interpolation to 0.1 second of arc is readily attained. Rotation angles up to 2000 seconds of arc can be measured. Measurement error does not exceed 0.1 percent of measured angle, or 0.02 second of arc, whichever is larger. Maximum working distance is 25 feet.

A versatile instrument! Other uses for this high-precision interferometer include measurement of absolute pressure, gravity level reference, sphericity, film thickness, surface parallelism, refractive index differences and homogeneity of transparent materials. It also handles many of the angle measuring tasks usually assigned to autocollimators, but with five times the sensitivity.

Informative 12-page bulletin contains complete data on Model K-421 and other new Kollmorgen optical tooling instruments: Single and Dual-Axis Autocollimators, Dual-Axis Automatic Autocollimator, Dual-Micrometer and Line-of-Sight Alignment Telescopes and all required accessories. Write today to Director of Instrument Sales for this bulletin, specifying whether you want early demonstrations.

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Somewhere between the original Model B klystron invented by the Varian brothers and the new TWYSTRON* hybrid amplifier is a Varian-built klystron, TWT, or BWO just right for your needs. And if we don't have it in the catalog, we *do* have the competence, ingenuity, and adaptability of talents to build a new tube for your socket. *TM VARIAN ASSOCIATES

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Circle No. 8 on Subscriber Service Card

Technical Countdown

ELECTRONICS

Celestial Fix for SINS Unneeded?

Sperry Gyroscope claims that by using a gyro turn-and-revise technique with its Mk 3 Mod 4 Ships Inertial Navigation System (SINS), gyro-drift errors are negated and the usual celestial fixes employed to correct the instrument are no longer needed. In the operational process, the input axis of a monitoring gyro is periodically reversed 180 degrees with respect to the SINS gyros. The normal error is thus reversed, says Sperry, eliminating the drift error effect. (Theoretically, the approach should work, however, it has not been reported to M/R that the technique has been tried successfully aboard any of the operational *Polaris* submarines. It is known that the British Navy has indicated it will employ such an approach to simplify its navigational systems aboard *Polaris*-armed vessels.)

Star Tracker Patent Issued

Two HRB-Singer engineers have been awarded a U.S. patent covering a new star-tracker navigational aid. Although applicable for use by ground observatories, the instrument is deemed most useful for high-altitude celestial navigation. Details of the device were not released by the firm, but it is known that it is capable of locking onto stars of predetermined magnitude over a fairly broad intensity range. Co-inventors are C. R. Ammerman and D. Larchuck.

MATERIALS

New Nozzle Coating Cuts Temperature

A ceramic coating produced by North American's Los Angeles division and applied to titanium nozzle extensions of the *Apollo* engine for tests resulted in a 200°F reduction in the temperature of the coated nozzle. Developers claim the temperature control coating discards 95% of the excess heat generated in the materials it protects, or, in the case of titanium, 60% more heat than the metal could radiate in an uncoated state. The coating is a mixture of ceramic oxide powders bound with liquid phosphate. It is applied with conventional spray equipment and cured at 600°F.

Latrobe's Vacuum Melt Facility Completed

Super-pure vacuum steels can now be produced in huge quantities with the completion and operation of Latrobe Steel Co.'s new $5.5-million Therm-I-Vac (TM) facility. The unit produces 60,000 lbs. of steel per heat as compared to existing furnaces upper limit of 16,000 lbs. Steam ejection is used to pull a vacuum of 5 microns in the vacuum induction crucible. Hot steel is poured into the chamber and explodes into thousands of droplets while the undesirable gasses are sucked from the metal. Further degassing occurs during boiling of the melt and magnetic mixing. The process results in extremely clean ingots aimed at applications in the bearing, turbine, aircraft structural and tool steel markets.

Compressibility Data on Rubber at Low Pressures

Scientists at the National Bureau of Standards Institute for Materials Research have completed studies into the compressibility of rubber at low pressures. Both unvulcanized and lightly vulcanized rubbers were investigated. The pressures and temperatures ranged from 0 to 500 kg/cm² and 0 to 25° C, respectively. The project was handled by L. A. Wood and G. M. Martin of the Institute's Staff. Only two samples of natural rubber were involved.

Fluid Power Dimensions Standard Initiated

The Dimension Identification Code for Fluid Power Cylinders, developed in 1960 by the National Fluid Power Assn., has been approved as an American standard by the American Standards Assn. The code is the first step in the trend to standardize dimensions for fluid power cylinders. While it does not set standard dimensions, the code establishes a fixed reference point for cylinder and mounting dimensions, identification letters for envelope dimensions and such letters for port sizes and locations. Copies of the standard are available from the NFPA, P.O. Box 49, Thiensville, Wis., 53092.

Dow Expands Epoxy Resin Production

Production capacity of expoy resins at the Dow Chemical Co.'s Freeport, Tex., plant will be expanded 75% to an annual output of 35 million lbs. The plant was brought on stream in 1962 with a rated annual production of 20 million lbs. Coatings applications take about 40% of the current output with future markets in reinforced plastic operations such as filament wound pressure vessels and solid rocket cases expected to increase significantly. Dow also supplies its DER 332 resin to United Technology for the *Titan III-C* solid strap-on propellants.

PROPULSION

Linde Air Separation Plant for Cape

An air separation plant with a rated output of 400 tons of liquid oxygen and nitrogen per day will be built and operated by Union Carbide Corp.'s Linde Division in the Cape Kennedy-Winterhaven, Fla. area. Initially the plant will produce about 200 tons of the cryogenic fluids per day. The facility will serve the launching center as well as Southeastern U.S. steel plants and the Florida citrus juice packaging industry.

Hybrid's Isp 20% Above Solids

United Technology Center has fired the highest performance hybrid yet tested under an ARPA funded program. UTC experts are following an approach that will increase the specific impulse of the hybrid 20% over currently operating solid rockets. Details of hybrid technology at the United Aircraft Corp. division were presented at the Aviation Space Writers Assn. annual meeting last week in Miami, Fla.

'Poodle' Interests Saturn Officials

STL low-thrust radioisotope system using liquid hydrogen propellant is proposed for Titan II, Saturn S-1 application

by Willard E. Wilks

REDONDO BEACH, CALIF.—NASA *Saturn* program officials have expressed interest in a low-thrust radioisotope propulsion system that TRW Space Technology Laboratories calls a miniature version of the Rover nuclear rocket engine.

Outgrowth of a $570,000 Atomic Energy Commission contract under which STL explored the spectrum of potential non-electric power-producing radioisotope applications in space, the device was dubbed "Poodle" to show its kinship to Rover. Its propellant is liquid hydrogen.

STL estimates that for $54.2 million a Poodle rocket stage could be developed to perform the type of missions envisioned in the Rover program. The firm proposes an upper stage for *Titan II* utilizing four of its Poodle thrusters to place 2,300 lbs. into synchronous orbit, or an application to *Saturn* S-1 that could put 40,000 lbs. into circular orbit.

STL's early design calls for an engine 3 in. in diameter and 13.5 in. long, producing a quarter-lb. of thrust at 700-800 I_{sp}. The direct-cycle engine would employ alpha-emitting Polonium-210 to heat an H_2 working fluid and expel it through a nozzle.

The system also is being proposed for deep-space probes and military evasive satellites.

● **Money-saver**—STL reports that approximate cost analyses indicate that use of Poodle-powered stages for currently established NASA launches would save more than $350 million by 1975, exclusive of radioisotope costs. Calculations based on AEC cost data show that about $30 million worth of Polonium would be required for these missions.

"Poodle promises large additional savings for many other NASA and military missions for which accurate cost data do not yet exist," STL says.

Many of the missions which, from an economic standpoint, appear impractical for chemical systems "can be performed quite economically with Poodle-powered stages," according to STL. The range of mission capabilities for such stages for medium-class launch vehicles —*Atlas* or *Titan*—includes solar escape, solar probes, and out-of-the-ecliptic.

STL's examination of NASA missions planned for launch in the next decade "indicates that the vast majority involve launch of payloads less than 2,500 lbs. Although firm numbers are not yet available, it is apparent that most future military launches will also involve payloads in this size range."

● **Versatility**—In transferring payloads from low to high orbit, the Poodle stage would be injected into low Earth orbit by conventional chemical boosters, and after startup would spiral slowly out to desired orbit.

Optimum performance on deep-space probe missions would require the stage to be propelled by chemical booster to velocities near that of Earth escape before startup of *Poodle* thrusters.

Application to continuous random-orbit perturbations would enable military satellites to avoid interception.

STL lists these general characteristics of Poodle stages: Less than 10,000 lbs. weight, insignificant surrounding radiation field, hence no elaborate launch ground support equipment needed; I_{sp}'s of 700 secs. from current fuel form developments; pressure-fed, using H_2 boiloff-tank pressures about one atmosphere gauge; accelerations between 10^{-3} and 10^{-4} g's; thrusters provide pitch, yaw and roll control.

● **How it stands**—Current status of Poodle technology at STL includes resistively-heated thrusters in operation, subscale thrusters scheduled for test this year and key propulsion system component development under way, with 700-sec. I_{sp}'s attainable soon.

Polonium production capability at AEC's Mound laboratory will be more than adequate to satisfy Poodle's requirements by the end of this year, STL reports, adding that this material was chosen because of the low radiation field, high power density, moderate cost, and high potential availability.

Scope of STL's Poodle program this year includes more detailed aerospace safety studies, radioisotope capsule and coating experiments, high-temperature H_2 heat exchanger development, subsystem technology analysis and experiments, expanded mission studies, low-thrust orbital mechanics investigation, and cost/effectiveness studies.

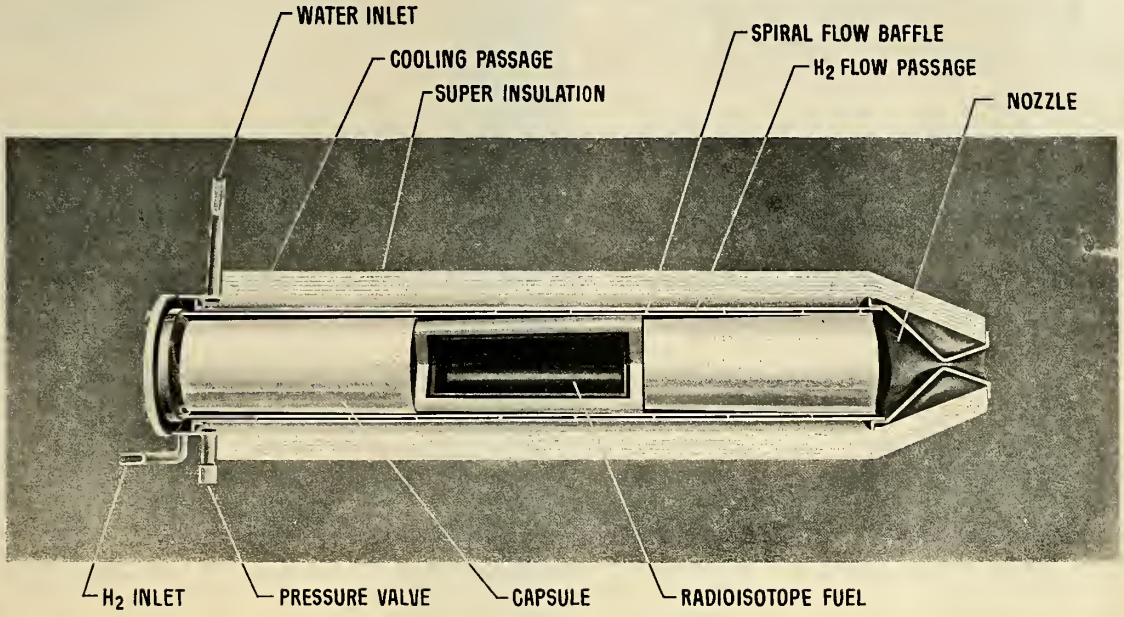
Apart from the Poodle application, the firm reports, the most promising nonelectric radioisotope space applications identified to date include satellite reaction control hot-gas sources, thermal control devices, life-support system operations, zero-g propellant gauges, starters for chemical monopropellant engines, and ablation gauges. ■

SNAP-Poodle Planned

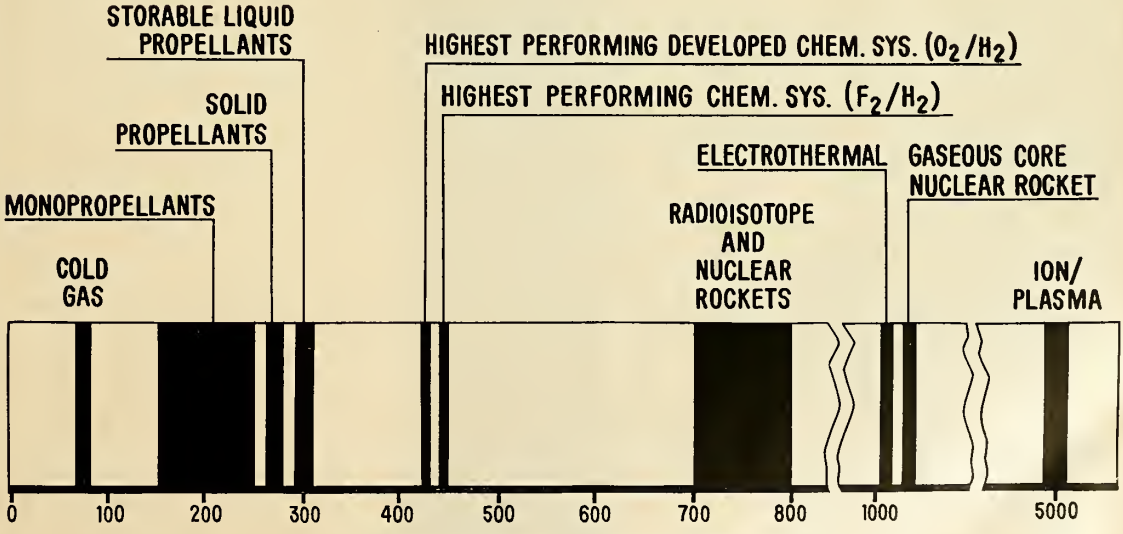
NEXT STEP in the projected Poodle concept, STL officials say, is a SNAP-Poodle. Excess heat from the radioisotope fuel would be used as an energy source for electric power for on-board instruments and telemetry. It is expected that direct conversion of energy will be used, through either thermionic or thermoelectric devices.

Experience with nuclear devices in *Transit* satellites indicates that SNAP-Poodle would be an easy extension of Poodle. The two nuclear-powered *Transits* launched in 1963 are still operating.

1. DIRECT CYCLE, Po-210 HEATED THRUSTER
2. H_2 WORKING FLUID
3. THRUST LEVELS 1/4 LB. PER THRUSTER MODULE
4. SPECIFIC IMPULSES ABOVE 700 SECS.



ABOVE: Cutaway drawing provides basic description of Poodle thruster. BELOW: The specific impulse spectrum.

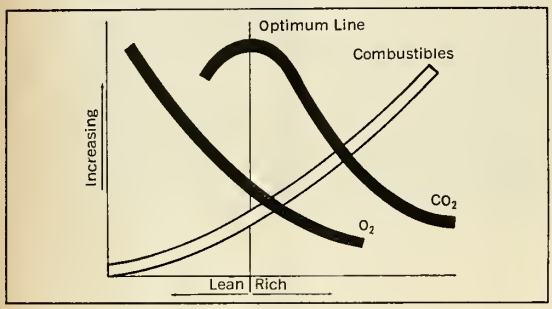


$$I_{SP} = \frac{\text{THRUST}}{\text{PROPELLANT MASS FLOW RATE}} = \frac{\text{TOTAL IMPULSE}}{\text{MASS OF PROPELLANT}}$$

You're wrong if you think that's just smoke. It's your profit drifting away.

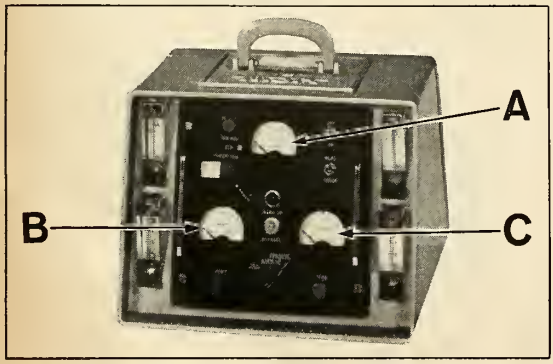
The more thoroughly you can analyze combustion, the more you will reduce fuel waste. What you save in operating costs is a direct contribution to net profits.

How can this be done most effectively? We believe that our new M-S-A® Portable Combustion Analyzer provides an answer based on sound engineering principles: Measure *all three* major components of combustion gases—oxygen, CO_2 and total combustibles. Then you can arrive at a point of maximum combustion efficiency, as shown on chart.



The M-S-A Portable Combustion Analyzer weighs just 30 lbs. This is an important convenience. It can be taken from one furnace to another in your plant; used to check combustion engines; moved easily to wherever you need it. It's compact, rugged, every inch a topnotch product of MSA research and engineering.

Send for our illustrated bulletin 0703-8. Or contact your MSA representative for a demonstration. Instrument Division, Mine Safety Appliances Company, Pittsburgh, Pa. 15208.



The M-S-A Portable Combustion Analyzer combines three instruments in one to give simultaneous measurements of all three significant components of combustion gas. A pump draws combustion gas to all three analysis cells simultaneously. The three meters give continuous readings. This allows you to monitor adjustments constantly until you reach optimum efficiency. A indicates the percent of oxygen in combustion gas, from 0 to 25%. B indicates from 0 to 20% carbon dioxide. C indicates from 0 to 10% total combustibles. With these readings, you can accurately determine the hydrogen-carbon ratio, percent of excess air and fuel-air ratio.

MSA

Circle No. 9 on Subscriber Service Card

AF, NASA Officials Enthusiastic About LPC's 156-in. Motor Test

110-second static firing termed 'major milestone' on way to developing big solids for both missile and space use

REDLANDS, CALIF.—Test firing of the first 156-in. solid rocket motor at Lockheed Propulsion Co.'s Potrero, Calif., facility last week was hailed by Air Force and NASA observers as initiating "a new era."

Air Force sources foresaw use of the 156-in. motor for both space and missile applications, including delivery of non-nuclear bomb payloads in limited war, and NASA spokesmen said post-*Apollo* missions may develop for the motor.

Brig. Gen. Joseph Bleymaier, deputy commander for manned systems, Air Force Space Systems Division, said the 110-sec. static firing of the one-segment motor, termed successful in all respects, signified "a completely new era with regard to the size of solid motors for ballistic missiles, and in particular, for space boosters."

Examination of test data showed the 156-in. performed as programmed during firing. Thrust levels followed the prescribed thrust time curve. There was an almost instantaneous buildup to full thrust, which maintained a fairly flat curve, followed by a comparatively fast tailoff. Average thrust was just under 900,000 lbs. Maximum thrust exceeded one million lbs.

Col. Harold W. Robbins, director of SSD's large solid rocket motor program, told MISSILES AND ROCKETS that possibilities considered for the 156-in. motor included use "in limited war, that is, a sort of *V-2* for non-nuclear weapons in case you want to put up 200,000 pounds of bombs, as a space launcher and as a ballistic missile."

He indicated there may be some consideration being given to use of such a booster in defense against ICBMs.

● **NASA interest voiced**—William



SUCCESSFUL static firing of 156-in. solid propellant rocket motor at Lockheed Propulsion Co.'s Potrero, Calif., facility May 28 demonstrated capability of maraging steel casing and jet tab system for controlling direction of rocket thrust. Test was conducted under executive management of AFSC's Space Systems Division.





LEFT: Penny holding the attention of Brig. Gen. Joseph Bleymaier, USAF, deputy commander for manned space systems, Space Systems Div., and Robert F. Hurt, president of LPC, remained in position on thrust stand during test. ABOVE: Four of these large-scale jet tabs were used in the firing. This is one of four slightly different tab designs used in the test. Second firing will use eight tabs.

Cohen, NASA chief of solid propellant experimental engines, told M/R the space agency is studying feasibility of "clustering the 156-in. rocket for 500,000-lb. post-*Apollo* missions and for use as a strap-on assist for *Saturn* boosters."

He emphasized that the latter consideration was for post-*Apollo* configurations, not because of any deficiencies or payload problems in the program.

Cohen said the test was "especially gratifying for us," pointing out NASA has a number of 156-in. application studies under way.

"Two key things in the demonstration were the nozzle, the largest of its kind, and the performance of the maraging steel," he said. "The rocket case was made under non-laboratory conditions, under real production conditions since properties of maraging steel allow that without the usual heat treatment."

Production and firing of the motor also was a transportability test of the biggest rocket that could be moved over the nation's roadways. Air Force logistics experts followed closely the trucking of the motor case segments from their fabrication site in New York to California.

● **Big step forward**—Test objectives included demonstration of the jet tab thrust vector control (TVC) system, determination of the performance of a nozzle with an ablative plastic throat insert, and demonstration of suitability for large solid motors of segmented chambers made of 18% nickel maraging steel.

Four jet tabs using different materials but all tungsten alloys and derivatives and slightly different designs went the full test cycle. While they varied in performance, as expected, displaying varying amounts of erosion, all came through the firing. For the second firing of the motor case, tab design will be narrowed to one or two configurations.

All agencies concerned said they were satisfied that test results amounted to achievement of a major milestone.

The same motor case will be refurbished and loaded for a second test this fall to demonstrate a prototype motor fully controlled by a jet tab TVC system. To save money, the first test used only two pairs of tabs. Four pairs will be mounted in the nozzle exit plane for the second test. The motor will be loaded with about three-quarters of a million pounds of propellant, as against half a million pounds in the first test.

"It is significant that it is now about 10 months since the contract was negotiated with LPC," Robbins said. "In terms of bringing something out of the laboratory, such as maraging steel, into full-scale, it is the sort of thing that verifies our confidence." He had declared shortly before the firing that "today is the moment of truth for maraging steel."

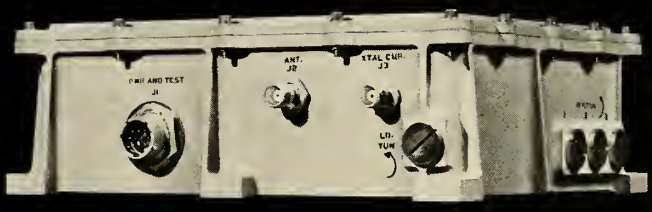
● **Prelude to 260-in.**—Air Force placed strong emphasis on the fact that the 156-in. firing was regarded as a subscale test for 260-in. motors. This also was true for the nozzle, which sources said could be scaled up to the 3 to 10-million-lb. thrust class.

One of the most critical aspects of the test was demonstration of the jet tabs, according to Robbins. He said preliminary inspection after the test revealed the four tabs showed only minor erosion as a result of some turbulent flow.

Regarding a few flaming pieces of material that spewed from the nozzle during the firing, he said that "unfortunately, graphite the size of a pinhead looks as big as a baseball when it comes out." He said this did not indicate problems in the motor, and added that there had been shielding material placed around at least a portion of the nozzle to prevent flame from spreading to the stand.

HIGH & MIGHTY

(but sensitive)



RADAR TRANSPONDERS

...e.g., precision C-band model AN/DPN-66 shown above—used on Saturn, Pershing and more than 15 other current aerospace programs. 800 w. nom. peak power, –70 dbm sensitivity, and 50 nanosec. delay stability.

The Motorola family of radar transponders is specified for critical tracking, data and control missions because of flight-proven performance and reliability over the wide range of aerospace missions. Superior delay stability, fast recovery time and demonstrated versatility make Motorola transponders the first choice on projects such as Centaur, Saturn, Pershing, Scout, and at WSMR, AMR, Eglin and Edwards AFB's.

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After the firing, measurement data indicated thrust level of 900,000-1,000,000 lbs. was reached and the motor otherwise met predicted performance levels.

Data also indicated no combustion instability. Five pennies stacked by a technician on an accessible portion of the motor assembly remained in place during the firing.

"We would make a few modest processing changes if we had to do it over again," Robbins said, "but nothing major. The motor was fabricated with very few problems." He noted that in 20 segmented motor firings since January, 1961, "we have not had one grain problem."

There was no thrust cut-off provision designed into the 156-in. motor "since we have not included that in large solids," he said.

The 120-in. motors designed for *Titan III-C* are about four-fifths the size of the single segment 156-in. motor.

● **Site being expanded**—LPC's President Robert F. Hurt told M/R new construction under way at the Potrero site will make it possible, if need be, to open the facility as a 156-in. motor production site in October. New equipment going in includes a 300-gal. Baker-Perkins vertical mixer and a large above-ground cast and cure station.

In October, the Potrero site will have reached its Phase II development, with ability to produce two motor segments and 500,000 lbs. of propellant per month, equalling the capability already available at the Redlands, Calif., plant nearby. In all, LPC will have invested about $6 million in 120-156-in. facilities at both sites in October.

Lockheed is leaving the 260-in. facilities race to others and says it does not plan to extend its own facilities to 260-in. capability unless business requires it.

If LPC does this, it would be on a site near water, not at either of its present locations. The company for a time had a legal finger on some land in Georgia for this purpose, but let the matter lapse.

Meanwhile, LPC plans indicate Lockheed believes the 156-in. program may be more likely to generate business in the foreseeable future than the 260-in. program because of possible military application.

The development plan for Potrero includes Phase III, which would boost 156-in. capability to two three-segment motors and 3 million lbs. of propellant per month, and Phase IV, which would boost this to six three-segment motors and 6 million lbs. per month.

There also are indications that one or two smaller solid rocket programs could produce some business for LPC's existing and projected 156-in. facilities, which can be adapted to accommodate smaller motors. ■

Test's Vital Statistics

Motor—Overall length, including nozzle, about 75 ft. One segment made in three sections (forward closure, 241 in.; center segment, 262 in.; aft closure, 220 in. Case, 18% nickel maraging steel. Fabrication, roll and weld construction, all TIG welding. Joint, clevis and tapered pins. Case was flightweight, with wall thickness of about ⅜ in.

Jet tabs—Sandwich structure consisting of a refractory metal face plate, a backup heat sink, and an insulated steel structural member; mounted on shaft and bearing assembly and rotated into jet stream by hydraulic servo actuators.

Propellant—Polybutadiene, acrylic acid, atomized aluminum powder, copolymer with advanced curatives, almost 500,000 lbs., thick web fraction, with round port.

Igniter—Pyrogen type, 58.5 in. long, 22.2 in. diameter, with high burning rate proepllant mounted in head end, four ports, angled 45 deg.

Nozzle—government-furnished for first firing, composite reinforced plastic, tape-wrapped, with ablative plastic throat. Weight about 6 tons, 9 ft. diameter, 8 ft. length. Largest fabricated to date with ablative throat.

Motor performance—Average thrust first firing, 900,000-1,000,000 lbs., duration 110 sec.

Contractors—Lockheed Propulsion Co., with Excelco Developments, Inc., motor case fabrication; U.S. Steel Corp., steel plate; Standard Steel Works Div. of Baldwin-Lima-Hamilton, steel forgings; Pittsburgh-Des Moines Steel Co., head forming & plate rolling; Mellon Institute, metallurgical support; Rohr Corp., insulation; TRW Electromechanical div., nozzle throat; Dealers Transit, Inc., motor transportation; Owl Construction Co., transporter vehicle development; Reynolds Metals Co., aluminum powder.

Gemini Fuel Cell Readied for GT-2 Flight, Now Scheduled for September

Improved version now in production at General Electric; program valued at more than $24 million; developers see possible use in such projects as Biosatellite, Gemini/MOL

by Michael Getler

WEST LYNN, MASS.—First flyable fuel cell system for the *Gemini* spacecraft has been delivered by General Electric Co.'s Direct Energy Conversion Operation (DECO), located here, to McDonnell Aircraft Corp., *Gemini* prime contractor.

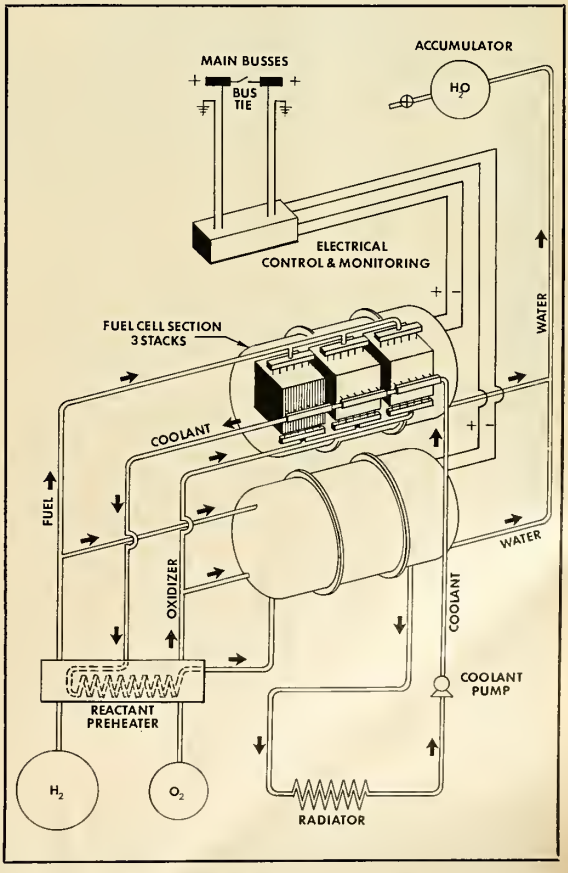
The unit is intended to fly aboard the next *Gemini* test flight, *GT-2,* slated to be launched in September. *GT-2,* an unmanned ballistic flight of about 20 minutes, will serve primarily as a subsystem operational check-out. First manned flight in which the fuel cells are expected to be aboard and functioning, both as the prime electrical power source and as a source of potable water for the astronaut crew, is the *GT-5* seven-day orbital mission scheduled for mid-1965.

The fuel cell system for the *GT-5* and subsequent flights will be an "improved" version, now in production at GE, which will reflect longer operating lifetime, primarily through refinements in the earlier flight system's "plumbing" and internal design. Timing of the development and necessary qualification testing for the improved cell relative to the cut-off dates for individual *Gemini* capsule lay-out did not permit its use in the three-orbit *GT-3* and four-day *GT-4* missions. These flights, as expected, will use a Project *Mercury*-type battery power system.

Sources close to the *Gemini* program say the GE fuel cell subcontract, including the aerospace ground equipment (AGE) being supplied by the firm's Ordnance Dept. in Pittsfield, Mass., now is estimated to have a total contract value of just over $24 million. GE-Pittsfield is supplying AGE equipment for use at DECO, McDonnell, and Cape Kennedy.

● **Other prospects**—In addition to *Gemini,* GE engineers are also looking toward application of the basic hydrogen-oxygen solid-electrolyte (ion exchange membrane—IEM) fuel cell they have evolved for this program to other projects.

In particular, they hope to use a repackaged version of the basic production-line cell in the *Biosatellite* (M/R, Sept. 2, p. 34) for which GE's Re-Entry Systems Dept. in Philadelphia holds the prime contract. Though no final decision has been made, DECO engineers told M/R they are "hoping for a contract." While *Biosatellite* would have a longer (30-day) mission requirement than *Gemini* (14 days), the power



BASIC flow pattern and layout of Gemini fuel system.



demands would be reduced.

Further along, engineers here see a possible expansion in use in the *Gemini/MOL* program. Requirements for conversion of *Gemini* to support the *MOL* space station mission are now under study at McDonnell. Increases in mission duration to about 30 days at increased power levels are likely.

GE engineers are also expected to make use of the technology in proposals for power sources on post-*Apollo* logistic and ferry vehicles and for mobile lunar surface rovers. For the lunar surface, they also postulate its use in combination with nuclear systems in a regenerative operation in which the water by-product of the cells is passed through a reactor to regenerate the hydrogen and oxygen components.

Development of a *Gemini* fuel cell system able to support the eventual 14-day mission requirement continues as an evolutionary process, with the recent cell improvements leading to what GE engineers feel will meet the specifications laid down by NASA. The "improved" cell now being turned out is still to be "qualified" in terms of meeting the complete specs. However, prequalification vibration tests have been passed and the first phases of the long-duration mission qualification have begun.

● **Chips on IEM**—GE engineers report that individual *Gemini* fuel cell stacks (each stack contains 32 individual cells, with three stacks making up one section and two sections making up a complete system) have operated successfully on life test for longer than the 14-day period, and that as production hardware becomes available, entire systems are now being fabricated for subsequent life testing.

GE's production line here is now turning out about 100 individual cells each week, equivalent to one complete *Gemini* system every two weeks. The firm says the line is capable of "substantial increases in production."

GE has bet heavily upon the IEM no-moving-parts approach as the one most advantageous for space systems design—mostly on the basis of trading off higher power for operational simplicity and, they hope, reliability, in a zero-g environment. While cells using liquid electrolytes yield higher voltages and current densities and operate at higher temperatures, engineers here feel that problems of containment of caustic liquid electrolytes and associated mechanical systems needed for water separation and pumping tip the scales towards the lower-powered IEM approach.

● **Other voices**—It should be noted that fuel cell technology is pushing ahead rapidly along several different lines, the number of firms in the field is increasing, and many firms are

achieving successful cell operation by various techniques.

In addition to the GE system, the other fuel cell program getting major funding from NASA is the liquid electrolyte cell system being developed for Project *Apollo* by the Pratt & Whitney Div. of United Aircraft Corp. That firm recently reported that the system has undergone a successful series of long-duration operating tests (M/R, May 18, p. 9).

● **How it functions**—The basic GE fuel cell works in the following manner:

The hydrogen fuel and the oxygen oxidizer for the cell are stored cryogenically in separate containers external to the individual fuel cell sections and are delivered to the cells via a system of lines, valves and filters which reduce the pressure of the gases enroute to the cell to about 20-30 psi as it enters the cells. The reactant supply system is being developed by the AiResearch Mfg. Co. Div. of the Garrett Corp. in Los Angeles.

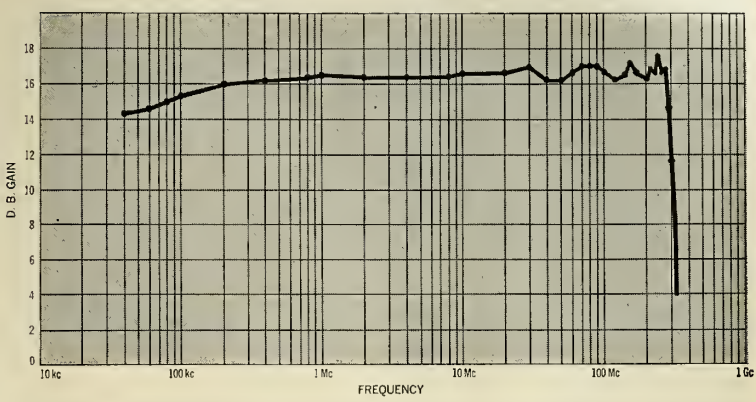
Each individual 10 x 10 in. cell to which these gases are delivered is made up of a single, very thin and "very tough" polystyrene ion-exchange membrane. On each side of the IEM is bonded a fine metallic-wire electrode screen which acts as anode and cathode. The electrode structure also includes a finely divided platinum which acts as a catalyst. And the electrode screen has a plastic binding layer for waterproofing.

On both sides of the membrane and its bonded electrode screen are metallic current carriers. These are ribbed and at right angles to each other to maintain contact with the membrane and electrodes. The hydrogen side of the cell is entirely enclosed, with the hydrogen gas entering each cell through a small inlet tube and circulating throughout the ribbed carriers to evenly distribute the flow across the electrode.

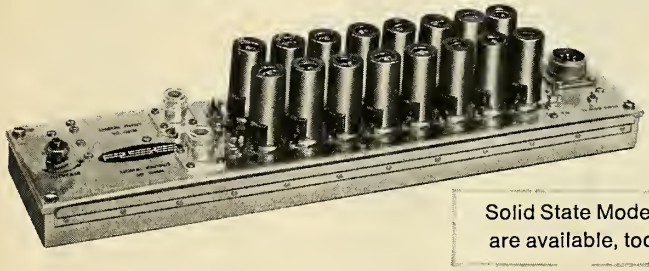
A second small tube on the hydrogen side is used to periodically purge any impurities from the reactant gas. This will be accomplished manually by the astronauts but may also be done automatically.

Oxygen, on the other hand, is freely admitted to the oxygen side of the cell from the atmosphere remaining within the individual sections, with coolant tubes running through the ribbed carriers. The coolant is supplied from the spacecraft's coolant supply located externally to the fuel cell sections. The coolant tubes are used to carry off the heat developed during normal fuel cell operation. The current carriers on the oxygen side also contain "wicks," spaced between the coolant tubes, which serve to carry off the water which eventually becomes part of the drinking water supply for the astronauts.

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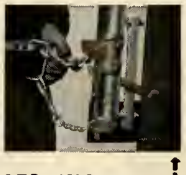


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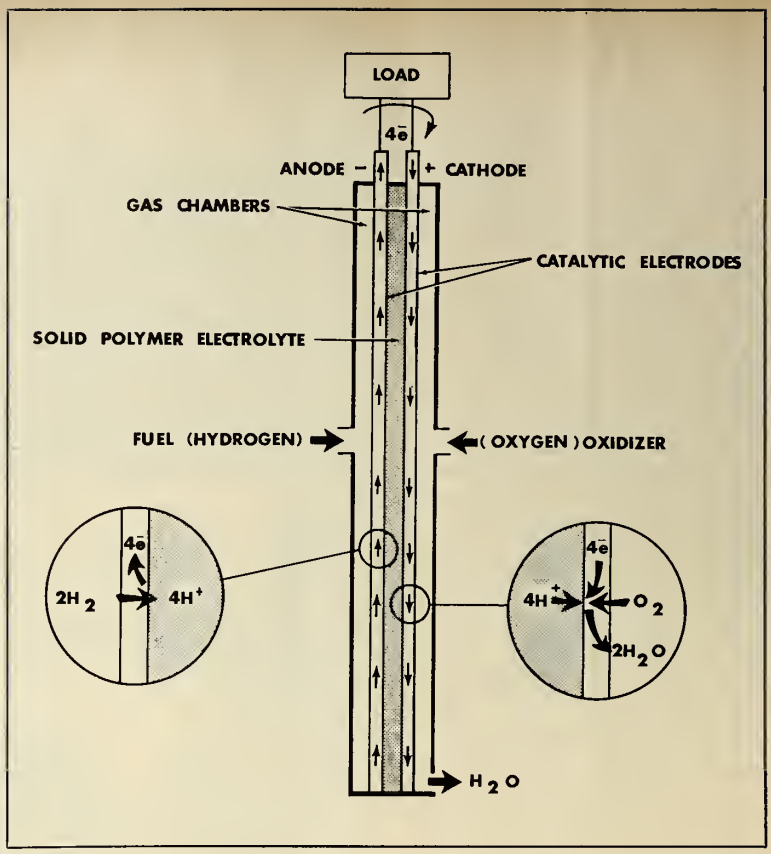
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The water condenses onto the wicks and is carried off along the wicks by capillary action, moving from a moist area to one less moist, finally running into a felt pad or "wicking bus" where water from all wicks in an individual cell is collected. In contact with the wicking bus is a water separator plate.

GE uses a unique, no-moving-part, static pressure-differential water separation system in which a low oxygen pressure is exerted on the water to force it through the separator plate, thereby removing the oxygen and leaving only potable water for the astronauts.

Both the use of a solid electrolyte and the capillary action-pressure differ-

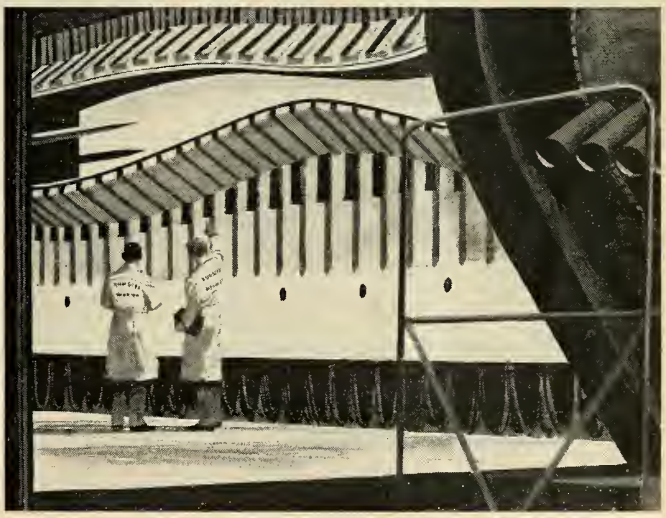


TOP OF PAGE: Highly simplified drawing shows action of solid electrolyte cell. RIGHT: Cutaway view of an individual cell from the hydrogen side shows ribbed hydrogen carriers, inlet and purge tubes on right, and enclosure. Visible on the top and bottom are portions of the oxygen side of the cell, which sandwiches the IEM electrolyte. The white strips at the bottom are the wicks which carry off water.

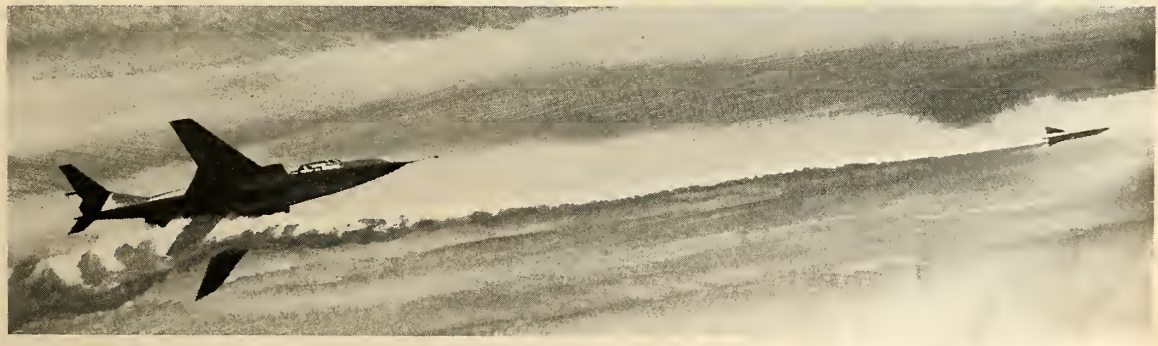
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ASSEMBLED three-stack section is shown here under final check-out at GE plant.

ential water separation system are cited by GE engineers as advantageous for zero-g operations.

● **Cell details**—Each stack of the *Gemini* fuel cell contains its 32 individual cells in a 5-in.-long enclosure. The cells are connected in series to build up voltage, with the stacks connected in parallel to form three-stack sealed sections, two of which are combined in the total system.

The two fuel cell sections operating together will produce up to 2 kw peak power. They can also operate individually, producing a single kw each. Individual stacks can continue to function in a section in the event one of the stacks fails. However, upon failure of a single cell within a stack the stack can be shut down. Each can, or three-stack section, measures 2 ft. long and 1 ft. in diameter, and the complete system, including the water normally inside and excluding the external reactant supply system, weighs 145 lbs.

The system is expected to produce up to one pint of potable water per kw hour.

The *Gemini* cell operates in the 100-140°F range and falls within the 50-60% practical thermal efficiency category over which IEM-type cells reportedly operate.

The IEM cell of the type used on *Gemini* falls into a generic operating category of about .7 volts at current densities ranging between 50-100 amp/ft². Liquid electrolyte cells are believed to operate at up to about 1.23 volts with higher current densities, due primarily to the ease in which ions can move.

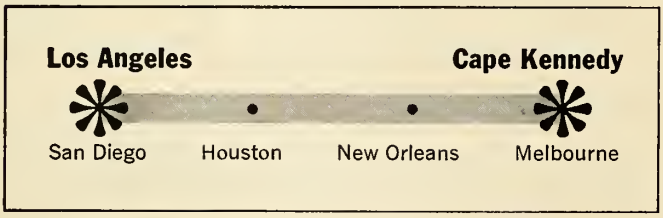
Most of the improvements made in the *Gemini* cell are in modifications to the hydrogen reactant lines to provide better flow and more even distribution across the electrode. Engineers also claim some improvements in the electrolyte; details are proprietary.

● **Pressing on**—There is considerable effort within industry to either improve existing solid electrolytes or find new materials to extend the life of the membrane and thereby extend the life of the cell. The search, GE says, is for oxidation-resistant electrolytes—since it is the oxidation mechanism which limits membrane life. Major research is also under way to define more accurately the nature of the breakdown mechanism. Among the possibilities is a chemical additive to the electrolyte which would oxidize rather than the electrolyte. NASA scientists add that new, less expensive catalysts, or more efficient use of platinum, is also desirable.

While the *Gemini* fuel cell remains to be qualified as a system, GE engineers point out that "the IEM clearly has the capability of extremely long missions." GE engineers told M/R that single design-lab IEM cells, though not *Gemini* cells, have run for up to 330 days. To date, they add, lab cells have run satisfactorily for over 2,000 hours through load cycles at about 28 watts/ft², but with occasional operation for two-hour periods at 80 watts/ft² or 170 amps/ft² at .5 volts.

Scientists, however, always caution against extrapolation of single cell or even single stack performance in an attempt to define an entire system. ■

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Manned Spacecraft Center Combines Food Programs for Apollo, Gemini

HOUSTON, TEX.—NASA's Manned Spacecraft Center has assumed responsibility for development of both *Gemini* and *Apollo* astronaut food systems and will combine them into one for both programs.

"We are now trying to develop the optimum diet and system for *Gemini*, using some of the technology that went into development of the *Apollo* system, with the intention of applying the same food program to *Apollo*," a NASA spokesman said.

"We have found that the astronauts would prefer to stay on the same type of food system and not be switched over to something else for *Apollo*."

The switch was made just as North American Aviation's Space and Information Systems division and Stanford Research Institute were completing their preliminary finalization on the *Apollo* food system, meaning that some basic concepts evolved out of nine months of study were to be stated in a preliminary specification. North American still is submitting its series of reports on the work.

NASA spokesmen said the change would mean "a radical shift of responsibility—where the food system was contractor-furnished before, it will now be government-furnished, including the water pistol to put water into the food bags."

● **The Gemini menu**—The present prototype *Gemini* foods will be used in *Apollo* habitability studies. This diet currently includes high-quality freeze-dried meats, soups, desserts and fruits, bite-size sandwiches, bite-size meat meals, salads, cake squares, powdered juices and tea.

Differences in the present *Gemini* food system and that recommended in the NAA-SRI study include:

—*Freeze dried foods*—The *Gemini* system uses less of these, more bite-size sandwiches that need no rehydration.

—*Food preparation*—The NAA-SRI study recommended that in dishes consisting of a number of ingredients, the ingredients be freeze-dried individually and mixed in that state to await rehydration rather than cooking them together and then freeze-drying the resultant mixture.

The reason given for this was that individual ingredients had different freeze-drying characteristics and quality was lost if they were freeze-dried together. MSC takes the view that taste quality is lost if ingredients are not cooked together before freeze-drying.

—*Food bag*—The plastic feeding bag designed for *Gemini* has an entry port for the water pistol separate from the folding feeder tube. This feature, incorporating a flapper valve, was designed after *Mercury* astronaut Maj. Gordon Cooper reported that water leaked from the food bags, posing a potential problem in the cabin as the water pistol was withdrawn from the bag.

In the new bag, the flapper valve prevents this. *Gemini* bags are 3 in. x 7 in., while the NAA-SRI bag is 4 in. x 13 in.

● **Coloric intake**—As the *Gemini* system is upgraded to a system compatible with both programs, some NAA-SRI recommendations may be incorporated.

Already set by NASA is the requirement that the food system provide 2,800 calories per man/day for the Command Module, and about 3,200 per man/day for the Lunar Excursion Module (LEM). A change in these figures probably would not affect the requirement that the total food provided for three men for 14 days not exceed 80 lbs. in weight and 5,000 cu. in. in volume.

Some observers believe it is conceivable that the figures could change a bit in view of some controversy over the amount of energy astronauts will use under zero-g.

"There is indirect evidence that astronauts may use more energy in zero-g than in 1-g," a spokesman said. "Man has been trained to use gravity as a tool. At least it holds him in place when he uses leverage. In zero-g, there is counter movement and you must expend energy to stop it. Further manned flights are needed to settle this."

In the Command Module, pressurized at 5 psi, water at 155° F will be available for rehydration to provide hot meals. In the Lunar Excursion Module, pressurized at 3.5 psi, foods will be room temperature—70-80° F—as currently planned, since water at only that temperature will be available. Menus in LEM may differ somewhat from those in the Command Module since some freeze-dried ingredients do not rehydrate properly at the lower temperature.

Still to be worked out is a satisfactory method of permitting astronauts to eat with faceplates on. In event of emergency decompression, food will be squeezed through a valve in the faceplate.

● **Apollo staples**—*Apollo* food will be about 12% protein, 37% fat, and 51% carbohydrates. Eight separate menus covering three meals a day and snacks are planned. Main meal will be repeated only every eighth day, the others every fourth day.

Although research, including a study of astronaut food preferences, has enabled preparation of a number of suggested menus, final menus will be selected only after astronauts have been chosen for the trip to meet their individual preferences.

Astronaut preferences so far surveyed by SRI, which is conducting most of the R&D under subcontract to S&ID, include crab newburg, beef with spaghetti and tomato, ham in mustard sauce, mashed potatoes, Swedish meat balls, chili con carne with crackers, chicken with potatoes and gravy, and seafood with noodles.

In the menus prepared so far, big meal of the day is the second rather than the third.

Material that appears to be the best moisture barrier for food packaging is aluminum foil and polyethylene laminate. Since it is desirable to have meals visible, however, foil will be used only to wrap a man-day meal unit. For the bags, Charles, a laminate of Aclar, Saran and polyethylene looks best so far. Other than packaging, no special storage is planned for foods. ■

TEST EQUIPMENT NEWS

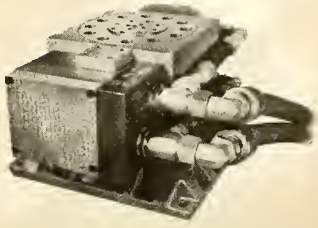
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Test the big loads...and at big displacements on MB Hydraulic Shaker Systems (and save big money, too)

MB Hydraulic Shaker Systems can perform vibration tests at extremely high forces and high displacements in the low to intermediate frequency range. These shakers can vibrate loads of 100,000 pounds and heavier. Combinations of exciters can be programmed to provide vibratory motion automatically in any combination of planes or degrees of freedom.

Save money, too. For many applications the cost of hydraulic shakers is substantially less than electrodynamic shakers. For tests requiring forces on the order of 100,000 lbs., the cost advantage can be 5 to 1, or more. To these advantages, add MB's complete check-out service. Write for a new hydraulic shaker booklet: MB Electronics, A Division of Textron Electronics Inc., 781 Whalley Ave., New Haven, Conn. 06508.



MB ELECTRONICS

Circle No. 14 on Subscriber Service Card



He started a revolution—and the heads began to roll

Back in June, 1960, a far-sighted customer asked a revolutionary question. Was it possible to produce a tape recorder/reproducer with a frequency range to 1.5 mc?

The highest frequency the industry could offer was 600 kc. How, then, could we hope to *more than double* the prevailing state-of-the-art?

Our engineers weren't sure. But they were sure that the answer lay in a completely new approach to recording head design. So they started designing. Then redesigning. Refinement followed refinement.

Nine months later, they proved the customer was right. They had perfected a head that not only recorded data to 1.5 mc, but also reduced head wear and cleaning to a minimum. The secret? A special, solid metal pole-tip design that eliminated the drawbacks of conventional lamination.

With this revolutionary development, our engineers had created a recorder that incorporated many other important advances as well. We call it the VR-3600. Our customers call it the "world's finest recorder."

This is a case in point of how customers have played (and continue to play) an important role in maintaining CEC's leadership in all areas of data recording — from ground-based telemetry to shipboard installations.

It's also the reason why CEC maintains a network of 22 sales and service offices throughout the nation. To help train customer personnel in the use of advanced instrumentation. To make sure that every product — new or old — is compatible with the latest and most advanced techniques.

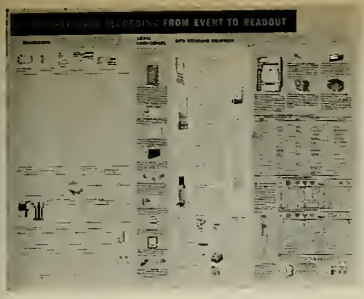


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INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND AND FRANKFURT/MAIN, GERMANY

Circle No. 15 on Subscriber Service Card



This chart is for you

Schematically arranged, this CEC chart covers each instrument of data recording equipment in the four primary categories shown below — plus basic specifications, cross-reference tables to aid in selection of instrumentation, and information on how to use combinations of the various instruments to meet specific needs. And should you be interested in support equipment for dynamic measuring in industrial or military applications — these important units are included and described as well.

Sensors and Pickups



Chart shows the 43 available for pressure, vibration, acceleration.

Signal Conditioners

Chart shows 11 basic types and where they may be required.





Magnetic Tape

Chart shows 8 analog and digital recorder/reproducers with support equipment.



Direct Readout

Chart shows 5 recording oscillographs, 33 galvanometers and where they can be used. Also support equipment.

Write today for your courtesy copy. Ask for CEC Chart DM-37-X31.

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Circle No. 16 on Subscriber Service Card

Gemini Experiments Will Explore Weightlessness

THE SPACE MEDICAL community now appears to be split into two camps over the role which weightlessness may play in cardiovascular deconditioning.

The post-flight experiences of astronauts Walter Schirra and Gordon Cooper brought the problem into prominence. Both evidenced a condition of "orthostatic hypotension" upon egress from their capsules onto the recovery ships. Schirra's resulted in blood pooling in his legs and Cooper's in a temporary dizzy spell. Both had decreased blood pressure, which lasted many hours after the flight.

There has been increasing feeling that any number of conditions during the flight, apart from weightlessness, could have produced the problem.

● **No sweat**—One factor which could easily have caused the condition, some doctors feel, is the extreme dehydration both astronauts experienced. In fact, two doctors at Lankenau Hospital, Philadelphia, conducted a study in which a single subject showed a marked increase in the effect when he was dehydrated as well as in bed rest.

● **Air Force experience**—Doctors from the School of Aerospace Medicine also report in the Journal of Aerospace Medicine that a group of 36 subjects confined in a space cabin simulator test all had a general decrease in orthostatic tolerance.

All subjects had a normal 24-hour-day cycle, and frequent periods of sitting upright and intermittent work-sleep periods. The general conclusion was that weightlessness, or even the prone position may not be responsible for the effect, but that the key is the amount or lack of physical exercise.

Dr. Lawrence Lamb also points out that "it is difficult to state that the observations reported were not influenced by the fatigue factor." He also lists temperature, immobilization, and the emotional effect or "post-mission letdown" as possible culprits.

● **NASA approach**—NASA doctors are meeting the problem head on with a list of medical experiments for manned *Gemini* flights designed to settle the question.

Dr. W. Randolph Lovelace II, new director of aerospace medicine in the Office of Manned Spaceflight, listed these experiments:

—M-1—cardiovascular reflex conditioning experiment; cuffs, exercise, tilt table. Before the flights, the astronauts will be checked on the tilt table for blood pressure, pulse and respiration. During the flight, blood-pressure cuffs on the thighs and upper arms will be inflated every five minutes to 50 mm of mercury, or 1 psi.

—M-2—cardiovascular effects of space flight—tilt table: astronauts will be measured in the flat, supine and tilt position to see if there is any fainting or other symptom of detrimental effects.

—M-3—in-flight exercise: work tolerance—the astronaut may work with the Bungee cord or strain against a strap.

—M-4—in-flight phonocardiogram—doctors suspect there may be a slowing of the heart in weightlessness. This instrument is designed to detect the speed at which the heart contracts.

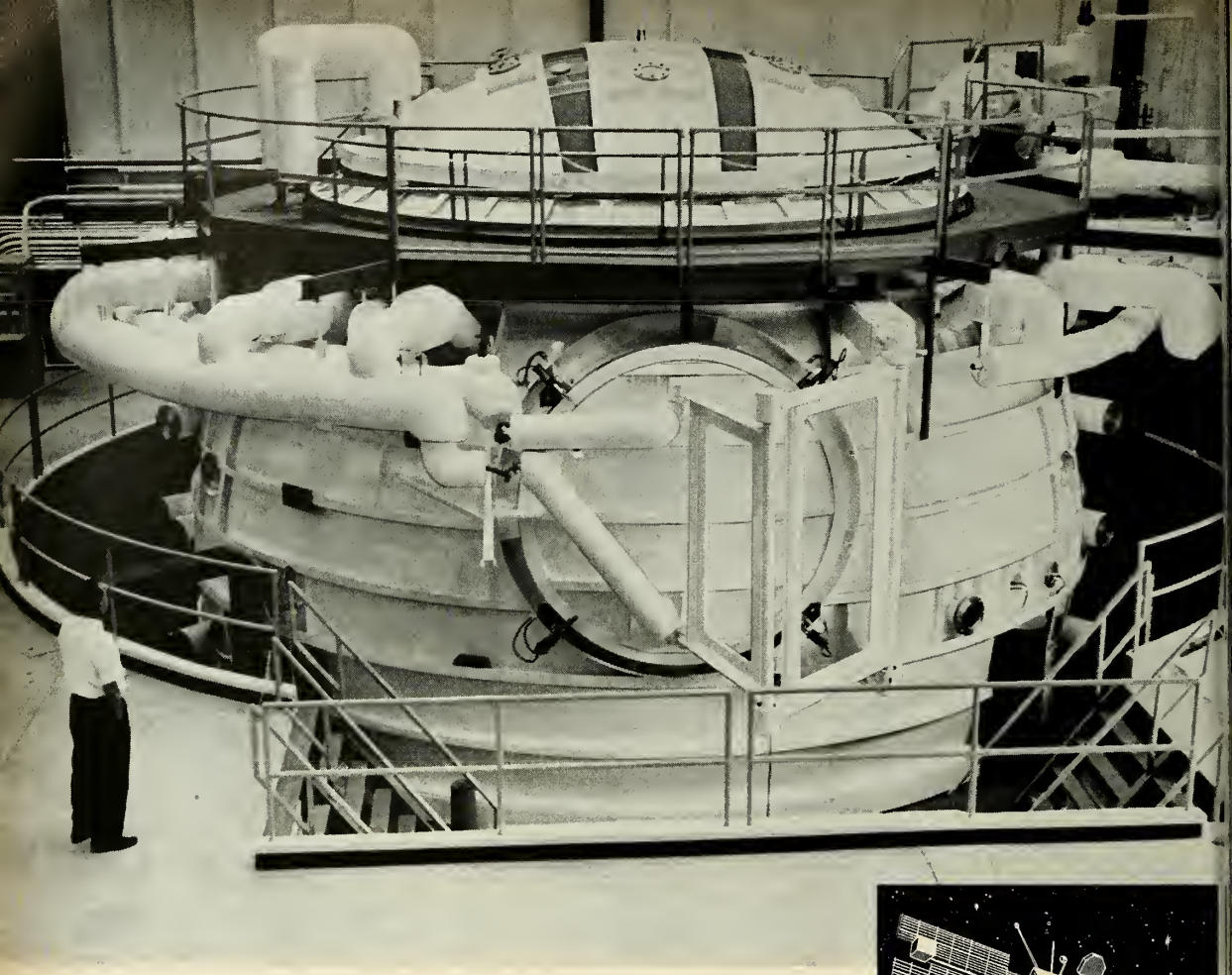
—M-5—biochemical analysis of body fluids: steriods, catechols—a continuation of the *Mercury* program in which block samples are taken before and after flight for evidence of stress.

—M-6—bone densitrometry during spaceflight—extremely sensitive X-ray equipment has been developed which will be used to determine how much calcium was lost in the astronauts' bones.

—M-7—calcium balance studies: calcium, nitrogen hydroxyproline—the calcium output and intake of each astronaut will be very carefully controlled for two weeks before flight, then measured in in-flight samples and after flight in urine, feces and blood.

M-8—in-flight electro-encephalogram—(EEG)—this will be the first use of an electro-encephalogram on humans in the space program. Electrodes will not be implanted.

—M-9—vestibular experiment—Dr. Ashton Graybiel, who has done most of the work on disorientation in the United States, has developed a piece of equipment which will be used to tell if orientation mechanisms function the same way in weightlessness as in 1 g. ■



OGO'S OUTER SPACE TEST TUBE A COMPLETE PROJECT BY CB&I

A new space simulation system which is now being used to test NASA's Orbiting Geophysical Observatory (OGO) spacecraft was completely designed and supplied by CB&I.

This is the largest system designed and supplied by a single contractor, without subcontracting the chamber, thermal system or vacuum system.

CB&I was awarded the complete project by TRW Space Technology Laboratories, designer and builder of OGO and other spacecraft in the nation's major space programs. The TRW installation is further demonstration of CB&I's outstanding reputation for designing, fabricating and constructing complete space simulation systems.

The next time you have an environmental testing system to be built —for space simulation or not—call on CB&I's complete capabilities. A "world of experience" awaits your inquiry. Chicago Bridge & Iron Company, Oak Brook, Illinois. Offices and subsidiaries throughout the world.

CB-6320-R1



"Test tube" for OGO...

The high vacuum and temperature extremes needed to bring outer space down to earth are created inside a 30-foot diameter stainless steel Hortonsphere.® Here vacuums to 3×10^{-9} torr (equal to a 380-mile altitude) will be reached, with temperatures from −30 to +275°F.

Super-efficiency of the vacuum system was proved in test when 1×10^{-6} torr was reached in less than three hours of an allotted 12. A special feature of the system is the diffusion pump trap – designed and supplied by CB&I – which permits egress of gas molecules while preventing entrance of oil molecules from the pump.

75th year CB&I **designs them! builds them!**

Circle No. 17 on Subscriber Service Card

Mergers and Acquisitions

Ling-Tempco-Vought, Inc., is seeking to acquire from its stockholders not more than 1.5-million shares of its own common stock. Purpose is to "provide the company with greater flexibility in financing any future expansion of the business activities of LTV." The firm is offering to shareholders, for each three shares of LTV common, $15 cash and one share of new series B cumulative convertable subordinated preferred stock. . . . *Control Data Corp., Minneapolis, has purchased Computer Laboratories, Inc., a Houston subsidiary of Scientific Computers, Inc. Computer Laboratories is a computing center specializing in oil industry activities in the Houston area.* . . . The boards of directors of Hercules Powder Co. and Haveg Industries, Inc., both headquartered in Wilmington, Del., have approved a plan for the acquisition by Hercules of Haveg. The proposed acquisition, still subject to approval of Haveg stockholders, calls for issuance of a new series of Hercules cumulative class A stock at the rate of two shares for each five shares of Haveg common. Haveg designs, develops and fabricates engineered plastics. . . . *Aerojet-General Corp. has purchased Gibbs Shipyards, Inc., Jacksonville, Fla. The yard, which has an annual business volume of $20 million and employes 1,400, will be operated as a wholly owned subsidiary of Aerojet, under the name Aerojet-General Shipyards, Inc. The yard will give increased emphasis to repair, servicing and construction of ships, but studies are also under way to determine ways the yard may support present Aerojet activities in oceanics.* . . . R. Allen Price has purchased the Denver-based manufacturers' representative organization, Parrish Electronics, Inc. Parrish represents manufacturers of electronic components and test equipment in the Rocky Mountain states from offices in Denver, Salt Lake City and Albuquerque.

New Activities

Ampex Corp., Redwood City, Calif., manufacturer of magnetic recording devices, has established a new military systems group in Culver City, Calif., to concentrate on the military systems market. Ampex has previously limited itself primarily to manufacturing for commercial markets. . . . *Sylvania Electric Products, Inc., has formed an Optics Dept. in Mountain View, Calif., to conduct research and development in the fields of laser communications and optical devices.* . . . Giannini Controls Corp., Duarte, Calif., has established a Nucleonics Dept. to develop industrial applications of the Company's nucleonic technology. The department intends to apply capability gained through aerospace programs to the industrial processing field. It will function as a unit of the Control/Nucleonics Div. . . . *Advance Industries, Inc., has been formed in Sioux City, Iowa, to fabricate, install and maintain microwave towers, microwave passive reflectors, electronic equipment buildings, heated and non-heated parabolic antenna radomes and associated accessories.*

Industry Facilities

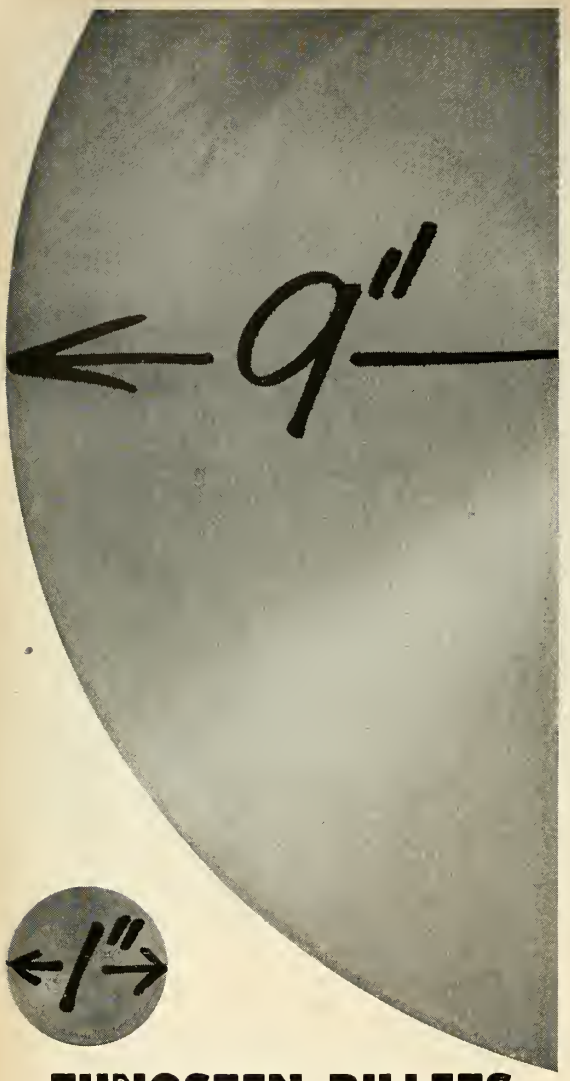
DeMarbro Electronics, a Boston electronics distributor, has moved into expanded facilities adjacent to its old location. The new building contains 22,500 sq. ft. of floor space. . . . *Melcor Electronics Corp. is nearing completion of a new 25,000-sq.-ft. plant in Farmingdale, N.Y. One half of the plant will be used for production, and assembly of the firm's amplifier products. The remainder will house offices, engineering laboratories, design and quality control departments.* . . . Zirconium Corp. of America, Solon, Ohio, has completed a plant expansion that adds 6,000 sq. ft. of capacity for the fabrication of high-temperature refractory products. . . . *Nuclear Data, Inc., Chicago-based manufacturer of nuclear analysis and measurement instruments has established a second research and development laboratory at its Eastern Div. headquarters in Hamden, Conn.* . . . Federal-Mogul-Bower Bearings, Inc., has purchased 15 acres of land in Ann Arbor, Michigan's Research Park and has announced plans for two new laboratories for its National Seal and Bearing Co. of America divisions there. Total size of the two buildings will be 55,000 sq. ft. The company already has in Ann Arbor research facilities totaling 23,600 sq. ft. . . . *On Mark Couplings, a division of Purolator Products, Inc., has completed transfer of its operations to Purolator's new western division headquarters in Rancho Conejo, Calif. The move to the new center will consolidate all of Purolator's missile/space and aircraft operations under one roof.*

GIC Turns Losses to Profits

General Instrument Corp. credits improved operating results in the areas of semiconductors-microcircuitry, military systems and equipment, and entertainment electronics with effecting a "gratifying recovery" from a net loss last year to a profit this fiscal year (ending Feb. 29) amounting to 46 cents per share of common stock. "The most dramatic turnaround," according to a report issued by the company, was in its military systems and equipment operations, which had incurred large losses in the two preceding years.

California Leads in DOD Dollars

California, with some $3.7 billion in DOD prime contracts, again led all other states during the first three quarters of FY'64 in net value of military procurement actions. The amount is 21.4% of the national total. Ranking of other states in the top 10: New York, 9.2%; Missouri, 7.4%; Texas, 6.2%; Washington, 5%; Connecticut, 4.7%; Ohio, 4.3%; Massachusetts, 4.1%; Florida, 3.8%; and New Jersey, 3.5%. The big move was for Missouri, which rose from tenth position last year to third this year.



TUNGSTEN BILLETS

1" TO 9" IN DIAMETER and preforms up to one foot! General Electric PS (pressed and sintered) Tungsten can be made in almost any size and shape you need. In billets and preforms for forging. In slabs for rolling. In electrode bars for vacuum arc melting. In shapes and forms for direct machining into missile hardware, crucibles, furnace boats, etc.

Where can *you* use the unusual properties of tungsten? 6170°F. melting point, excellent high-temperature strength, good thermal conductivity, good erosion resistance. General Electric PS Tungsten may be your material!

General Electric PS Tungsten also gives you the advantages of high purity (99.95% minimum) and high density (92% minimum). General Electric can supply you with PS Molybdenum, too. For information, write General Electric Co., Lamp Metals and Components Dept. MR-46, 21800 Tungsten Road, Cleveland, Ohio 44117.

Progress Is Our Most Important Product

GENERAL ELECTRIC

contracts

AWARDS

AIR FORCE

$5,800,000—**Tasker Instruments Corp.,** Van Nuys, Calif., for fast acting radar devices.

$2,300,000—**System Development Corp.,** Santa Monica, Calif., for work on a satellite control system.

$1,300,000—**General Dynamics Corp.,** Astronautics Div., San Diego, Calif., for launch support services related to the Army *Nike-Zeus* anti-ICBM missile system.

$1,300,000—**General Dynamics Corp.,** Astronautics Div., San Diego, Calif., for further production of *Atlas* standard launch vehicles.

$1,300,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for radar surveillance systems for use at missile sites.

$1,200,000—**Rand Corp.,** Santa Monica, Calif., for further work on Project Rand.

$1,200,000—**North Electric Co.,** *Galion,* Ohio, for automatic audio switching and control systems.

$1,100,000—**Hayes International Corp.,** Birmingham, Ala., for operation of a publications distribution center.

$173,860—**President and Fellows of Harvard College,** Cambridge, Mass., for research on theoretical studies of the interactions of particles and fields.

$126,000—**Itek Corp.,** Lexington, Mass., for a study of a controlled infrared photographic developer system.

ARMY

$5,800,000—**Sperry Rand Corp.,** Sperry Utah Co. Div., Salt Lake City, Utah, for continued production of *Sergeant* missile system components.

$2,900,000—**Martin Marietta Corp.,** Orlando, Fla., for further work on the *Pershing* missile system.

$2,800,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for work on a radar system.

$2,600,000—**Radio Corp. of America,** Moorestown, N.J., for two contracts to provide work on the TRADEX data recovery system.

$1,500,000—**International Business Machines Corp.,** Rockville, Md., for automatic EDP equipment.

$900,000—**North American Aviation, Inc.,** Columbus Div., Columbus, Ohio, for development and flight testing of an advanced version of the *Redhead Roadrunner* target missile.

$800,000—**Magnavox Co.,** New York City, for production of 11 advanced development models of an interim anti-jam subsystem for satellite communication link terminals, auxiliary items and engineering services.

$450,000—**Honeywell, Inc.,** California Ordnance Center, West Covina, Calif., for development of *Redeye* guided missile system simulators.

$141,000—**General Dynamics Corp.,** Electronics Div., San Diego, Calif., for a study contract resulting from previous studies to develop high-resolution techniques for surface radar systems.

NAVY

$7,600,000—**Vitro Corp. of America,** Silver Spring, Md., for follow-on engineering support services related to the *Talos, Terrier* and *Tartar* missiles.

$2,400,000—**Aeronca Manufacturing Corp.,** Aerocal Div., Middletown, Ohio, for airframe assemblies and missile components.

$1,500,000—**Hercules Powder Co.,** Cumberland, Md., for research and development work related to solid propellant systems.

$1,100,000—**G. C. Dewey Corp.,** New York City, for modification of communications equipment for the Marine Corps.

$450,000—**Bendix Corp.,** Mishawaka Div., Mishawaka, Ind., for product improvements, components and repair modifications to *Talos* missiles and test equipment.

$197,879—**Astrodata, Inc.,** Anaheim, Calif., for range timing operations centers.

NASA

$237,000,000—**General Dynamics Corp.,** Astronautics Div., San Diego, Calif., for construction of 14 hydro-fueled stages for *Centaur* vehicles.

$4,500,000—**Hayes International Corp.,** Birmingham, Ala., for engineering services and R&D work.

$1,300,000—**Telecomputing Services, Inc.,** Los Angeles, for computer operations in support of Marshall Space Flight Center's Michoud Operations, New Orleans, La.

$500,000—**Westinghouse Electric Corp.,** Baltimore, for multiple mechanical and electronic fabrication services.

$337,000—**System Development Corp.,** Santa Monica, Calif., for analytical studies supporting the *Orbiting Astronomical Observatory.*

$100,000—**North Carolina Science and Technology Research Center,** for establishment of an experimental program for the transfer of technology developed in the space effort to the use of civilian industry.

INDUSTRY

$1,000,000—**Texas Instruments, Inc.,** Dallas, from **Litton Industries, Inc.,** Beverly Hills, Calif., for production of semiconductor circuits.

$1,000,000—**Magnavox Co.,** New York City, from the **Royal Swedish Army Ordnance Dept.** for spare parts to support an FM vehicular communications system being provided by Magnavox through a previous contract.

Circle No. 18 on Subscriber Service Card

THE PURSUIT OF ENGINEERING EXCELLENCE

This statement of policy was presented to the membership of the McDonnell Aircraft Corporation Management Club by Vice-President of McDonnell Engineering, Mr. Kendall Perkins. If you, as an engineer, are encouraged to seek greater excellence in your work, you will gain. If you are successful in your search for excellence, the Nation will gain.

"The pursuit of engineering excellence doesn't get talked about much—perhaps because it seems so obvious. It should be talked about more, however, because too few engineers recognize its vital importance or go to enough trouble to achieve it.

"To excel means to surpass or outdo. As applied to the kinds of engineering with which our company is mostly concerned, the pursuit of excellence might be defined as the attempt to do a better engineering job than anyone else. This isn't easy. There are a great many smart and energetic people in the aerospace industry and we're competing for an amount of business which isn't enough to keep all the capable groups as busy as they would like to be. Of course, this makes excelling all the more necessary.

"To effectively outdo the competition, an individual or an organization must:

1. Be fully conscious of the need to do a better job,
2. Have the ability to do a better job,
3. Have the desire to do a better job,
4. Work under conditions which permit doing a better job, and
5. Keep up the effort without letup.

"It is rare to find all these conditions in fullest measure. But every one is necessary and the success of an organization depends on the presence of such conditions. The same may be said with respect to each individual in the organization.

"The first of these requirements is to *be fully conscious of the need to excel.* From the standpoint of the collective group—the company or the engineering divisions of the company — the need is apparent. From the standpoint of each individual engineer, you would think it would be equally obvious, but it doesn't always seem to be. Our contracts make us responsible for a major segment of progress of our Nation. They demand our finest performance. Excellence is to be expected of those given assignments indicative of great national trust.

"*The ability to excel* isn't equally given to all of us but that doesn't mean we can't do better than we do. There is such a close relation between the ability and the desire that those who are anxious enough to excel very often do. You will find that the most successful people are just as likely to have ordinary ability and an outstanding desire to excel as they are to have ordinary desire to excel and outstanding ability. Of course, there are those who have plenty of both, but they can take care of themselves.

"*The desire to excel* is like 'will to win' in a game. It's hard to measure beforehand, but the results are easy to see. It isn't nearly enough for someone in charge of a project or proposal to have the great drive to do a better job than anyone else has ever done. Our engineering jobs must now depend on the efforts of many people. Unless they have a collective 'will to win' the chance for proposal and product excellence is slight.

"By *working under conditions which permit doing a good job*, I do not mean keeping the office well lighted, or paying a high salary, although these factors are not unimportant. Creating and keeping an environment for best operation of a winning team is one of the most important responsibilities of engineering management. It calls for many things including, but certainly not limited to, these:

1. Recognition and appreciation of the special abilities and efforts of each individual,
2. Assignment of the maximum amount of the most difficult work to each individual in accordance with what that individual is capable of doing well,
3. Scrupulous insistence on fair treatment of all concerned including the customer,
4. Following policies which are consistent and understood,
5. Establishing and working toward objectives which are recognized as worthy,
6. Insisting that engineering decisions be made, insofar as practicable, on the basis of the over-all best interests of the largest appropriate group—the project, the company or the country, rather than primarily in the interest of individuals or their immediate groups,
7. Having the wisdom to avoid proposals unlikely to win, or projects unlikely to be fruitful, through no fault of the engineers who worked so hard toward their success,
8. In general, doing everything practicable to maintain a winning atmosphere.

"All this may sound unduly pious. But I really believe that promoting these conditions pays off in very practical ways.

"*Keeping up the effort* is probably the hardest condition to satisfy. As with other homely virtues, when effort is continued most consistently, it often seems appreciated least. There is no substitute, however, for the persistent expenditure of extra effort, otherwise known as 'hard work.' As in the case of almost all important creative accomplishments, notable success stems 10% from inspiration and 90% from perspiration.

"Although it seems harder each year to do the kind of engineering which excels, our competitors, and the Russians as well, have similar handicaps. We can keep ahead if we continue to exert ourselves in the pursuit of excellence. If we do this as well individually as we have in the past, I do not see how we can fail collectively to grow and prosper."

Additional engineers, scientists, physicists, and mathematicians with energy and enthusiasm are needed for projects in the National interest now underway at McDonnell. If you would like to work where the pursuit of excellence is a permanent corporate goal, the brief resume form below is included for your convenience.

MCDONNELL An Equal Opportunity Employer.

Mail This Form To: D. F. Waters, McDonnell Employment, Dept.62MM, Box 516, St. Louis, Mo., 63166

Name_____ Home Address_____

City & State_____ Phone_____ Age_____

Education: BS_____ Date MS_____ Date Ph D_____ Date Major Field:_____

Primary Experience Area:_____

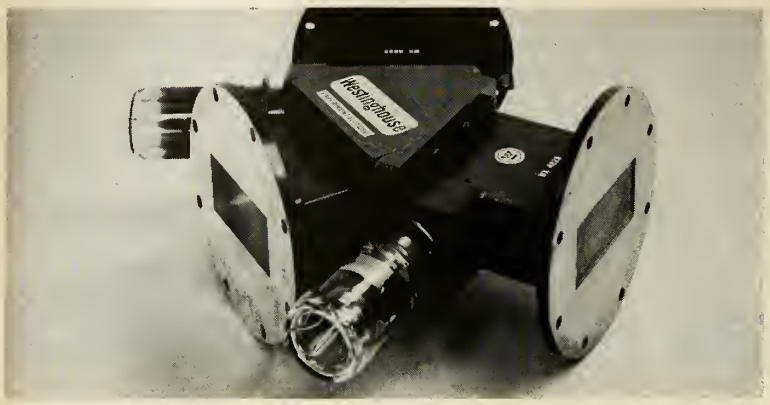
_____ Number of Years_____



Present Position:_____

_____ I would like to receive application form ☐

Circle No. 19 on Subscriber Service Cord



New Product of the Week: Microwave Switch

A 100-kw peak power single-pole, double-throw microwave switch for use in the S-band between 2.85 and 3.15 gc is available from Westinghouse Electronic Tube Div.

The WX-4825 is a gaseous tube controlled by an external pulse, which provides the basic switching action. It operates at an incident power of 100 kw peak at 0.0005 duty cycle. Feedthrough insertion loss is less than 0.3 db. Isolation is greater than 33 db to the third terminal.

A combination of these tubes can be used in a matrix to feed transmitter power from one input to any of several output terminals.

Circle No. 151 on Subscriber Service Card

Ultrasonic Particle Detector

A device that detects the ultrasonic "rattling" of foreign particles as small as 50 micrograms has been developed by Delcon Corp.

The Model 216 detector can inspect 8,000 to 10,000 transistors, microcircuits or other miniature components per day. The instrument accelerates components at the tip of a steel reed up to 200 g's. Ultrasonic energy in the 35,000 to 45,000-cps range is created if any foreign particles or mechanical defects signal a reject. The test reed transmits the signals produced to microphones, responsive only to ultrasonic energy, and the outputs from the microphones are programmed by logic circuitry to sample the four test stations and locate the fault.

Circle No. 152 on Subscriber Service Card

Pressure Transducer

Micro Systems, Inc., has introduced a semiconductor pressure transducer featuring a flush diaphragm and designed for high natural frequency and extreme accuracy under severe space propulsion environments.

The Model 1003-0013 measures pressures from 0-500 to 0-5,000 psia or psir (sealed gage). Nominal sensitivity is 0.5v over the specified range. Natural frequencies of the sensor are from 65,000 cps minimum for 500-psi and 150,000 cps minimum for 5,000-psi response. The gage withstands 150% overpressure and 300% minimum burst pressures. Combined error due to nonlinearity, hysteresis and repeatability is less than $\pm 0.5\%$ full scale.

Circle No. 153 on Subscriber Service Card

RF Attenuator

A rack-mounting attenuator for RF signals in the dc to 1,000-mc range is being produced by Telonic Industries, Inc.

Capable of attenuating inputs as much as 110 db, the device incorporates three turret-type attenuators to provide its full range in 1-db increments. One turret unit covers 10 db in 1-db steps; the other two may be switched over a 50-db spread in 10-db steps. All three are accumulative.

Available with 50 or 75-ohm impedance, the unit is designated Model TAD-50R or TAD-75R. Insertion loss is specified at 0.1 db to 30 mc, 0.5 db to 400 mc and 0.7 db to 1,000 mc.

Circle No. 154 on Subscriber Service Card

Isolation Amplifier

Natel Engineering Co., Inc., has developed the Model 9071 isolation amplifier, providing 500-k input impedance and 500-ohm output impedance in a package 0.8 x 2.6 x 2.25 in.

Frequency response of the unit is dc to 200 cps. Input, output and 28v dc power are completely isolated from each other. Input-to-output linearity is 0.5% over a temperature range from 0 to 165°F. Voltage gain is adjustable from 1.0 to 0.10. Sampling rate is 10 kc.

Circle No. 155 on Subscriber Service Card

Trigger Delay Generator

Electro-Optical Instruments, Inc., is marketing a trigger delay generator designed to provide pulses for triggering plasma experiments, flash X-ray systems, high-speed photographic systems and hyper-ballistic studies.

The Model 100 is a modular unit with a 10-nanosec. rise time and a 100 to 1,000-v variable pulse into a 50-ohm load. Delay is continuously variable from 50 nanoseconds to 2,500 microsecs. Jitter on all delays under 750 microsecs is less than 0.2%. From 750 to 2,500 microsecs., jitter is from 0.2 to 2%.

Circle No. 156 on Subscriber Service Card

High Speed Impulse Counter

Landis & Gyr, Inc., is marketing the Model SC60 impulse counter, rated at 250 counts/sec. with a life expectancy of more than one billion counts.

Models are available with 5, 6 or 7 digits, including one electronic stage for straight counting or predetermining. Power supply is 110v, 60 cycle. Other voltages are available on order.

Circle No. 157 on Subscriber Service Card

Cine Spectrograph

Barnes Engineering Co. is marketing the Model 18-134 cine spectrograph, a high-resolution instrument for photographing octave intervals of point-source spectra extending from the ultraviolet into the infrared region.

The device has a Maksutov optical system, which provides aberration-free images on a flat field, and a film transport mechanism with frame-to-frame alignment for recordings up to 3 minutes or more in duration. The optical system is corrected throughout the 0.2 to 2.6-micron range and is limited only



It takes a lot of people to make one system "go."

Space systems begin and end with people. Competent, reliable people.

And it's people who give ITT total in-house capability, who conceive, design, develop, fabricate, test, install, and operate space systems.

A few of their contributions to U. S. defense and space programs are:

...components such as high-current photomultipliers for star tracking, single storage tubes that combine radar and TV information displays, and the tiny yet extraordinarily reliable ITT microcircuit packages.

...hardware such as the Army geodetic satellite, an infrared radiometer for Nimbus, a lunar seismometer for Surveyor, a photoelectric camera and secondary power plant for Surveyor, and emergency power units for Apollo.

...conceptual design, engineering and installation of systems such as 465L for SAC Command Control and ACE High for NATO.

...maintenance and operation of systems such as the DEW Line and the electronic instrumentation and communications facilities at Point Arguello for PMR.

This depth of experience gives ITT's management insight into all factors involved in systems assignments—including the interface of individual segments, so vital to successful systems. Insight which is translated into better control, greater efficiency, and closer adherence to critical time tables.

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THESE ITT COMPANIES ARE ACTIVELY SERVING U. S. DEFENSE AND SPACE PROGRAMS: AMERICAN CABLE & RADIO CORPORATION, FEDERAL ELECTRIC CORPORATION, ITT CANNON ELECTRIC INC., ITT COMMUNICATION SYSTEMS, INC., ITT DATA AND INFORMATION SYSTEMS DIVISION, ITT ELECTRON TUBE DIVISION, ITT FEDERAL LABORATORIES, ITT GENERAL CONTROLS INC., ITT GILFILLAN INC., ITT INDUSTRIAL LABORATORIES DIVISION, ITT INDUSTRIAL PRODUCTS DIVISION, ITT INTELCOM INC., ITT KELLOGG COMMUNICATIONS SYSTEMS, ITT SEMI-CONDUCTORS, INC., ITT SURPRENANT INC., JENNINGS RADIO MANUFACTURING CORPORATION.

ITT

by the spectral transmittance of vitreous quartz elements within the system. The recording camera produces a 1.156 x 2.25-in. picture. The shutter can be adjusted for openings from 30 to 120 degrees in 30-degree increments.

The instrument operates from 50/60 cycles input, but is optionally available for 400-cycle operation.

Circle No. 158 on Subscriber Service Card

Electronic Cooling System

An electronic equipment cooling system, presently applied to tracking ships, has been introduced by Astro-Science Corp.

The ECS-10 system utilizes a central portable self-contained liquid chiller of 10-ton refrigeration capacity in conjunction with 12 or more "satellite" electronic rack cooling units. Chilled brine at 30°F is circulated through a primary coil in the rack cooler to lower the absolute humidity of air entering the electronic rack. A secondary coil utilizes a portion of the condenser water from the central chiller for reheating the air to the desired discharge temperature, which is controllable to ±2°F.

An automatic condensate disposal system is included in the unit. Air handling capabilities of each cooler are 225 cfm at 1½ in. water column pressure.

Circle No. 159 on Subscriber Service Card

Power Relays

A line of hermetically sealed power relays for missile/space application is available from Cutler-Hammer, Inc.

Available in 25 amp (3 PST), 50 amp (3 PST) and 100 amp (SPST) configurations, with or without auxiliary contacts, the line features a pancake magnet to cut weight and size.



A balanced armature provides vibration resistance of 15 g's at 750 cps and 12 g's at 750 to 1,500 cps. Impact shock resistance is 50 g's. Temperature range is −65° to 125°C. The line meets MIL-R-6106D requirements; the 25-amp relays conform to MS27997-D1 and D2.

Circle No. 160 on Subscriber Service Card

3-Axis Flight Simulator

Carco Electronics has available the Model S-480A three-axis flight simulator.

The unit is programmed by an analog computer, or function generator, to duplicate angular rotational motions of a missile or spacecraft during flight. Effects of Earth rotation are eliminated by tilting the outer axis parallel to the Earth's axis. A signal is then programmed to rotate this outer axis equal and opposite to the Earth's rotation.

The simulator provides a controlled dynamic velocity ratio of over 1,750,000:1. Angular acceleration exceeds 37,000 degrees/sec^2 and frequency response is in excess of 23 cps.

Circle No. 161 on Subscriber Service Card

Charge Amplifier

A small charge amplifier designed to withstand the environments of missile test stand applications is available from Gulton Industries, Inc.

The Model FR-0001 is modular in construction and designed for use with "charge" type piezoelectric transducers. Use of up to 1,000 ft. of low-noise coaxial input cable results in less than 1% change in sensitivity. Other specifications include: temperature range, zero to 130°F; vibration level, up to 10 g's peak; shock, 30 g's for 5 millisecs duration; gain accuracy, ±1% of specified range; output impedance, less than 30 ohms.

The unit weighs 3 lbs. and measures 1.75 x 3.4 x 14.3 in. The 115-v, 60-cps power supply is self-contained.

Circle No. 162 on Subscriber Service Card

Digital Programmer

Data Science Corp. has developed a building block approach based on magnetic core circuitry to meet any programmer or timer requirement for aerospace and similar applications.

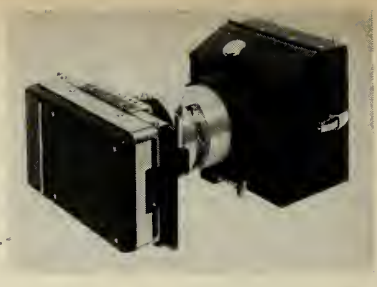
The "off-the-shelf" digital programmer provides either internal or external time base source to produce programmed outputs that may be event pulses, solid-state switching or relay switching. The system can provide a count capacity of 2,048 and operates from a 22 to 35v dc supply. Environmental temperature range is −55° to 100°C.

Circle No. 163 on Subscriber Service Card

Trace Recording Camera

Electronic Instrument Div. of General Atronics Corp. is marketing an oscilloscope trace recording camera designed for variable object to image ratio, rapid loading and immediate prints.

The Model GA-310 uses a Polaroid



film pack, an f/1.9 Oscillo-Raptor lens for edge-to-edge definition and a detented slide control for precision spacing of multiple exposure of 1 to 9 traces per exposure. A built-in viewing port or an optional binocular viewing hood permit direct viewing of the CRT screen.

Circle No. 164 on Subscriber Service Card

Miniature Tape Recorder

A miniature magnetic tape recorder that simultaneously records data on from 1 to 14 channels, in line or interlaced, has been announced by Data Recovery Systems, Inc.

The Model DR-1000 is available in speeds of 1.875, 3.75, 7.5, 15, 30 or 60 in. per second, with a tape capacity of 1,200 ft. of one mil polyester instrumentation tape. The unit measures 13.13 x 6.5 x 3.13 in. and weighs less than 13 lbs., complete with tape. Wow and flutter under static conditions is less than 1% peak-to-peak.

Circle No. 165 on Subscriber Service Card

Mono-Diode Whiskerless

Continental Device Corp. is marketing the mono-diode whiskerless with less than ¼ volume of the subminiature glass diode.

The device features oxide passivated junction and 100% burn-in at 300°C for 16 hours. Designed to meet MIL-S-19500C requirements, the diode has 250 mw power dissipation, de-rated to 200°C.

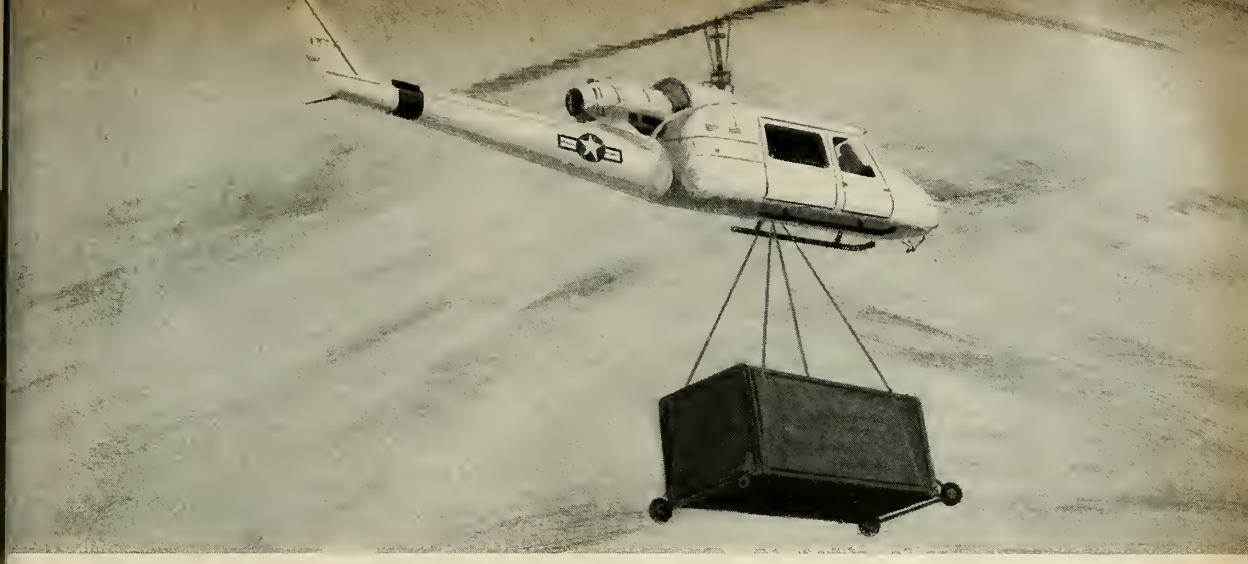
Circle No. 166 on Subscriber Service Card

Shaft-Angle Encoder

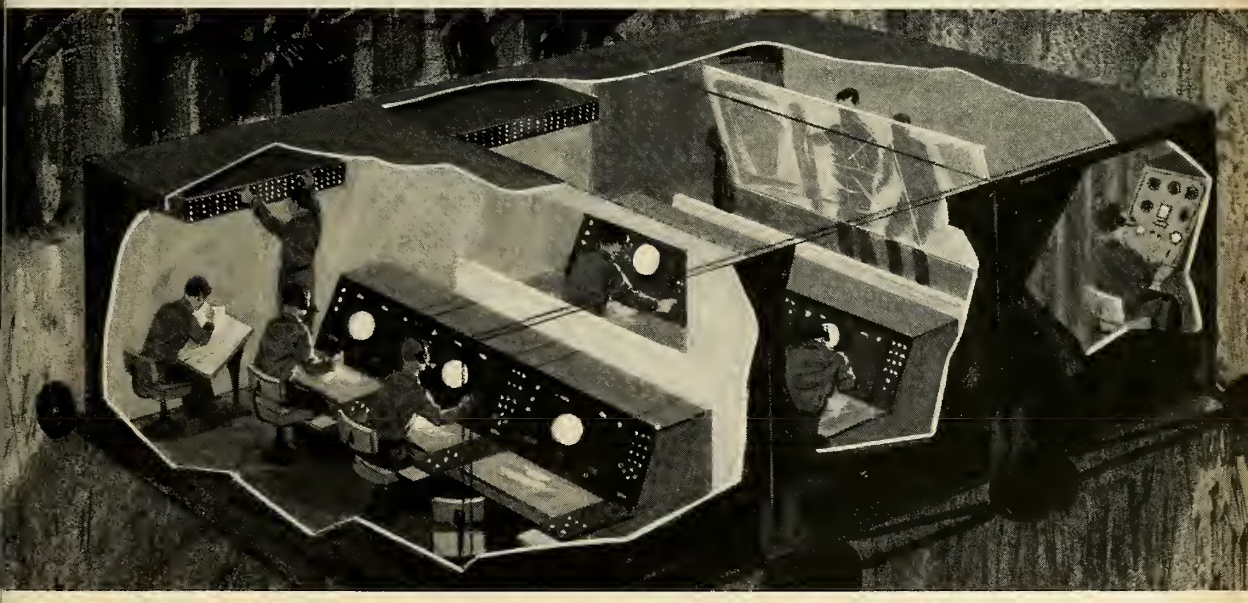
Dynamics Research Corp. has developed an optical shaft-angle encoder for use in star trackers, inertial platforms and guidance systems.

The device, called a Theodosyn, employs the theodolite optical "folding" technique to provide a readout of 2^{20} counts per revolution from a ruled disc of 3-in.-dia. Total system accuracy is within ±1 count or 1.24 seconds of arc. A separate 15-in.^{3} microcircuit module will convert the analog signals to a 2^{20} serial output of cw or ccw pulses and an once-per-revolution zero pulse.

Circle No. 167 on Subscriber Service Card



Deliver 3 Westinghouse mobile huts like this—



and you have a complete radar operations center

Until now, tactical operations centers have been large and unwieldy complexes. Time-consuming assembly and low intercept capacity have resulted in limited capability.

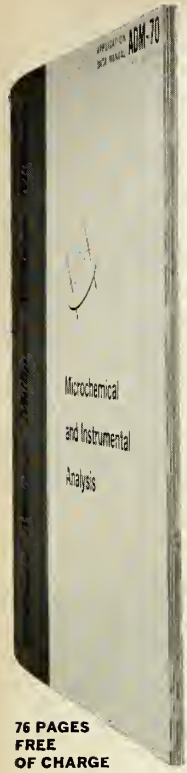
A new Westinghouse concept has changed the picture. The Westinghouse Mobile Radar Operations Center is a modular, pre-wired and pre-assembled system that adapts to the mission requirements. A basic three-hut configuration can be transported in a single C-130 and can be placed in operation in 20 minutes or less. To adapt to changing tactical situations, modules may be added or substracted. All huts are easily transportable over terrain on standard vehicles or with mobilizers.

The addition of DIGITRAC—an optional Westinghouse digital weapons control system—is a major aid to the weapons controller. DIGITRAC greatly increases capacity and accuracy in the control of tactical interceptors. The DIGITRAC control system can also provide highly mobile, ground-based guidance for close support, interdiction, resupply and air traffic control.

For complete information on the Westinghouse Mobile Radar Operations Center, write for Bulletin SD-1-1-4. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh, Pennsylvania 15230. J-02358

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Worth writing for

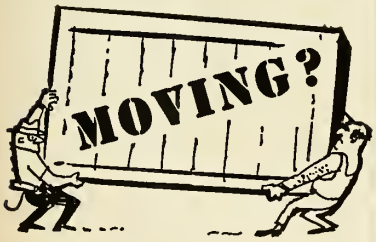
ADM-70, "Microchemical and Instrumental Analysis" describes techniques for identifying particulate contaminants, using Millipore filters, in optical and electron microscopy, microchemical spot tests, ring oven analysis, infrared and ultraviolet absorption spectroscopy, flame photometry, radio-activity analysis and other related methods. To get a copy of this manual, write to

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Automatic Spectrometer

Philips Electronic Instruments has developed the Norelco PW 1212 automatic spectrometer, capable of analyzing samples for as many as 15 elements from fluorine upward in the atomic scale.

In normal practice, the 15 elements can be selected from 24 preset values. Collimators, crystals, detectors, data collection, X-ray tube currents and voltages are then programmed for optimum performance. The instrument then automatically analyzes up to four samples for as many as 15 elements, printing results on tape.

Requirements include: electrical power, 220v, 30 amps, 50 or 60 cps; cooling water, 3.5 quarts/minute with maximum input temperature of 35°C.

Circle No. 168 on Subscriber Service Card

Resistance Standard

An advanced resistance standard providing high-range secondary resistance standards up to 10^{14} ohms has been developed by Angstrohm Precision, Inc.

The resistance calibrator is a subdivided transfer standard for 100-fold multiplication of values from NBS-type standards. Theoretical transfer accuracies of better than 1 ppm up to 100 megohms and effective transfer accuracies under ordinary production use of better than 50 ppm are obtained. The device may also be operated up to 10 megohms as an absolute standard for accuracies up to $\pm 0.02\%$ without the associated standard resistors.

Circle No. 169 on Subscriber Service Card

Automatic Range Selector

An automatic range selector providing five full-scale ranges from 100 mv to 1,000v is available from Hewlett-Packard Co.

The Model 3443A has an accuracy of 0.05% of readings and 10-mv resolution. A front-panel offset control makes it possible to nullify the thermoelectric effects of external connections. Input impedance is more than 10 megohms in all ranges.

Circle No. 170 on Subscriber Service Card

DC Biaser/Block

Antenna & Radome Research Assn. has introduced a broadband coaxial dc biaser/block covering a frequency range from 300 to 11,000 mc.

The Model 1-6572 has an insertion loss of 0.5 db maximum and RF isolation of 35 db minimum. VSWR is 1.5 maximum. The unit measures 0.88 by 2 in. dia.

Circle No. 171 on Subscriber Service Card

new literature

ENGINE INSTALLATION MANUAL—The Internal Combustion Engine Institute has published the "Engine Installation Manual" to inform and provide unbiased information about engine installations encompassing many brands. Topics include engine installations and selection; cooling systems; diesel, gasoline and gaseous fuels and fuels systems; air-intake systems and exhaust systems.

Circle No. 196 on Subscriber Service Card

ANALOG / DIGITAL CONVERSION HANDBOOK—Digital Equipment Corp. has available an "Analog-to-Digital Conversion Handbook," covering all phases of conversion from concepts to calibration. Simplified diagrams cover various methods of conversion for beginners. Numerous circuit diagrams and tables assist a designer in selecting, constructing and testing a complete A/D converter.

Circle No. 197 on Subscriber Service Card

PHOTOGRAPHIC MONITORING OF RADIATION—Eastman Kodak Co. has published a booklet describing the use of photographic films for monitoring radiation dosage, and including extensive data on personal monitoring films. "Kodak Personal Monitoring Films" incorporates a section of principles of photographic radiation dosimetry and a list of references. It also contains detailed sensitometric and processing data.

Circle No. 198 on Subscriber Service Card

CARBIDE TOOL GEOMETRY—A pocket-sized booklet on "Carbide Tool Geometry" is available from Adamas Carbide Corp. The publication is a compilation of six illustrated articles covering lead angles, end cutting edges, nose radius design, relief and clearance angles, rake angles and chip breakers. Also included is a tool trouble check list, designed as a quick reference for eliminating premature tool failure problems.

Circle No. 199 on Subscriber Service Card

CLEANING AND MATERIALS PROCESSING—"Symposium on Cleaning and Materials Processing for Electronics and Space Apparatus—STP 342" has been published by the American Society for Testing and Materials. The report, comprising 25 papers, reports on the technology of contamination control and processing, including methods for evaluation and control of airborne contaminants and the use of and control of high purity solvents and processing liquids. Price to ASTM members is $7.00; to others, $10.00.

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In addition, it will include a complete breakdown on the final fiscal 1965 missile/space budgets; a comprehensive guide on "where to go" and "whom to see" in each of the major procurement centers in DOD, NASA and the Services; and a fiscal 1964 chronology of the important events in the missile/space industry.

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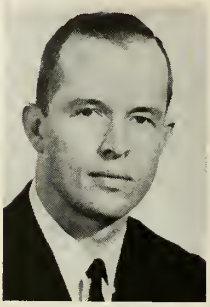
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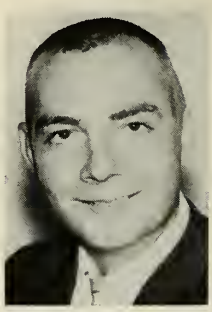
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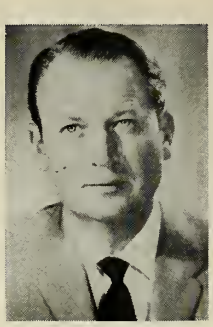
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names in the news


BROMBERG


McMURTRY


MATTOX


BRUNSON


SLADE

Howard P. Mason: Appointed vice president-sales manager, a newly created position at Aerojet-General Corp., El Monte, Calif.

Jack L. Bromberg: Appointed vice president and director of Douglas Aircraft Co., Inc.'s new Space Systems Center, Huntington Beach, Calif.

Dr. Burton J. McMurtry: Named manager of Sylvania Electric Products, Inc.'s recently formed Optics Dept. in Mountain View, Calif.

Ronald S. Wishart, Jr., and **Leon P. Jehle:** Appointed president and vice president, respectively, of Silicones Div. of Union Carbide Corp.

Robert C. Webb: Named vice president for engineering of Lantronics, Inc., Santa Monica, Calif.

Robert Bruce, Jr., and **Edward O. Cole:** Elected vice presidents of Fairchild Camera and Instrument Corp., Syosset, N.Y.

Walter H. Pagenkopf: Re-elected president of the Armed Forces Communications and Electronics Association for 1964-65. Pagenkopf is manager of the Indianapolis, Ind., Works, Western Electric Co., Inc.

Dr. Henry W. Riecken, Jr.: Appointed associate director for scientific personnel and education, National Science Foundation, Washington, D.C.

Reginald H. Mattox: Named vice president of planning and administration of Milgo Electronic Corp., Miami, Fla.

James J. DePalma: Named vice president and manager of marketing of Electro-Tec Corp., Ormond Beach, Fla.

Michel des Vallieres: Elected to the board of directors of Optics Technology, Inc., Belmont, Calif.

Peter J. Buck: Appointed vice president and managing director of Westrex Co., Ltd., London.

Jack I. Hamilton: Named vice president of sales at the Vard Div., Royal Industries, Inc., Pasadena, Calif.

Dr. Eric A. Walker: Elected chairman of the National Science Board, National Science Foundation, Washington, D.C. Walker is president of Pennsylvania State University. **Dr. Philip Handler** of Duke University was named vice chairman.

Robert M. Brunson: Named senior vice president, western region, of General Precision, Inc., Tarrytown, N.Y.

Clifford Williams: Joined Itek Corp., Lexington, Mass., as technical consultant.

Kelly Wemp: Appointed proposal manager and coordinator for the Electronics Div., Whittaker Corp., Los Angeles.

Sanford Greene: Appointed chief value analysis engineer of Fairchild Controls, a division of Fairchild Camera and Instrument Corp., Hicksville, N.Y.

Joseph Paul: Appointed manager of reliability for B. H. Hadley, Inc., Pomona, Calif.

Michael L. O'Conner: Named manager of the Telemetry Div., International Electronic Research Corp., Burbank, Calif.

Howard Carlson: Elected to the board of directors of Applied Technology, Inc., Palo Alto, Calif. Carlson is a company vice president.

Clair C. Pearson: Named program manager, command and control programs, for Electronic Communications, Inc., St. Petersburg, Fla.

Maj. Gen. John N. Ewbank, Jr., USAF: Named Tactical Air Command Deputy for Operations, Langley AFB, Va. **Col. George Schenkein,** USAF, was named information officer for the Tactical Air Command.

O. A. Thornsjo: Named director of Honeywell, Inc.'s *Apollo* program, Minneapolis, Minn. **J. S. Wagner** was appointed deputy director.

Edwin Slade: Named eastern marketing manager for Brunswick Corp.'s Defense Products Div., Englewood Cliffs, N.J.

Hugh Stebner: Named manager of industrial applications for Avtron Manufacturing, Inc., Cleveland.

George S. Mauksch: Appointed director of planning for American Cable and Radio Corp., New York City.

Dennis Royalty: Appointed administrative engineer for the Research, Development and Engineering Dept. of Cryenco, Denver, Colo.

Lee M. Springer: Named manager of engineering services for Electro-Optical Systems, Inc., Pasadena, Calif.

Charles A. Peacock: Appointed assistant to the president of Federal Electric Corp., Paramus, N.J.

Saul H. Ludwig: Appointed staff planner at Computer Measurements Co., San Fernando, Calif.

C. R. Campbell: Named programs manager for Defense Electronics, Inc., Rockville, Md.

James A. O'Malley, Jr.: Appointed manager of aircraft and missiles marketing for Bell Aerosystems Co., Buffalo, N.Y.

John H. Pamperin: Appointed president of the Advanced Technology Laboratories Div. of American-Standard, Mountain View, Calif.

Vincent R. Grillo: Joined Computer Sciences Corp. as director of plans and programs, Washington, D.C.

Robert J. Janda: Appointed manager of contracts for Douglas Missile & Space Systems Div., Santa Monica.

D. B. Annan: Appointed vice president and general manager of The de Havilland Aircraft of Canada, Ltd.'s special products and applied research division, Downsview, Ontario.

Rich Winkler: Named western regional manager of the Tech-Center Div. of Cook Electric Co., Los Angeles.

R. G. Cumings: Named director of data products for Defense Electronics, Inc., Rockville, Md.

—when and where—

JUNE

Symposium on Quasi-Optics, sponsored by the Polytechnic Institute of Brooklyn, IEEE, U.S. Army Research Office, U.S. Air Force and U.S. Navy, Statler-Hilton Hotel, New York City, June 8-10.

Systems Engineering Conference and Exposition, New York Coliseum, New York City, June 8-11.

Sixth National Electromagnetic Compatibility Symposium, IEEE, Los Angeles, June 9-11.

National Electronic Packaging Conference, New York Hilton Hotel, New York City, June 9-11.

Seminar on "Computer Applications to Structural Engineering," Illinois Institute of Technology Research Center, Chicago, June 10.

10th Annual Meeting, American Nuclear Society, Sheraton Hotel, Philadelphia, June 10-14.

Eighth Annual Product Engineering and Production Conference, IEEE, Pratt Institute, Brooklyn, N.Y., June 11-12.

20th Annual National Meeting of the Institute of Navigation, Barbizon Plaza Hotel, New York City, June 15-17.

Symposium on Molecular Structure and Spectroscopy, OSU, ONR, NSF, Ohio State University, Columbus, June 15-19.

Summer Scientific Seminar on Communication Cybernetics, sponsored by the Air Force Office of Scientific Research, Cloudcroft, N.M., June 15-26.

Special Summer Conference on the Scientific Mission and Engineering Design of an Orbiting Astronomical Observatory, New York University School of Engineering and Science, New York City, June 15-26.

International Conference on Physics and Chemistry, Air Force Office of Scientific Research, Brown University, Providence, R.I., June 21-26.

Seminar on Microcircuit Equipment, Mesa Scientific Corp., Ambassador Hotel, Los Angeles, June 22-23.

67th Annual Meeting, American Society for Testing and Materials, Chicago, June 22-24.

International Conference on Photosensitization in Solids, sponsored by the Air Force Cambridge Research Laboratories, ONR, Space Physics Laboratory and Illinois Institute of Technology, Chicago, June 22-24.

Seventh Molecular Beam Conference and Institute on Molecular Beams, sponsored by the Air Force Office of Scientific Research, Brookhaven National Laboratory and Uppsala University, Uppsala, Sweden, June 22-July 7.

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The Search

IN NOVEMBER, 1962, there was a disheartening setback in this country's program to develop nuclear rocket propulsion. The KIWI-B4A reactor, demonstrating what might politely be termed an unacceptable degree of instability, was heavily damaged by flow-induced vibrations during a power test.

We therefore want to call attention to a significant stride forward for the nuclear rocket program with last month's successful operation of the KIWI-B4D reactor at Jackass Flats, Nevada. The May 13 run could not immediately be pronounced a success because a hydrogen leak touched off a fire that left some questions about the reactor.

But on May 29, Dr. Harold B. Finger, manager of the Space Nuclear Propulsion Office for the Atomic Energy Commission and the National Aeronautics and Space Administration, reported to the annual news conference of the Aviation/Space Writers Assn.:

"Examination of reactor parts and data analysis completed as of May 27, 1964, indicates successful operation of the reactor."

This is a major milestone in the project and follows 18 months of redesign, analysis, component testing, and cold-flow tests of the KIWI-B4A and KIWI-B4B reactors. Despite the November, 1962, disaster, these convinced the AEC-NASA-industry team that the design approach taken by Los Alamos and Westinghouse could achieve a stable reactor.

The May 13 run, despite the unfortunate fire, is vindication of that effort. The hydrogen leak which touched off the fire occurred outside the reactor, in the jet nozzle, where some of the coolant tubes in the regeneratively cooled nozzle separated from the pressure shell. This leaked hydrogen out of the nozzle where it ignited and caused the inlet hydrogen duct insulation and painted surfaces to burn.

The reactor itself continued to operate stably and reliably. The shutdown was a normal one following pre-planned procedures. Shutdown took place after slightly more than a minute of operation at maximum power. Maximum temperature was maintained for over a minute and a half.

Dr. Finger describes his reaction this way:

"For a few seconds at the end of the test, I (and I am sure everyone else in the room) consciously thought through the major objectives of the test to determine if the run duration was long enough to assure that the major objectives had been met. I felt an exciting and emotional reaction when I realized that it was. The operation of the reactor certainly appeared successful. Nothing had left the reactor, the jet was fully expanded and appeared absolutely clean, there were no flashes in the jet as had been experienced in the KIWI-B4A reactor test in November, 1962, none of the vibrations that had caused damage to that reactor were detected in this test, and extensive data had been recorded on the reactor performance."

Teardown of the reactor has justified Dr. Finger's first flush of success. Further reactor testing is scheduled this year and next, to be followed by operation of an engine system in which reactor and all of the important non-reactor components are coupled.

But last month's test marked more than a milestone in the program. It demonstrated what a determined and capable design team can accomplish in the face of setbacks in research and development. Despite the discouragement of the 1962 reactor failure and the heartache of Congressional disenchantment, the efforts of the AEC, NASA, Westinghouse, Aerojet and other contractors continued unabated.

They met the challenge despite the fact that there is no firm mission requirement for their engine, despite the fact that there is no assurance that it ever will fly.

It is important to remember this when studying the nation's research into advanced technology. In addition to carrying out approved programs, we must also establish the technology to permit undertaking of any advanced missions we may decide are desirable.

This is not an expensive undertaking. About 10% of the Fiscal 1965 NASA budget, for example, goes for advancement of technology, some $500 million. The need for this investment is clearly expressed by Dr. Finger:

"The future missions conducted will be determined by the technological capability available in advance of major decisions."

It is to retain this option that funding of programs such as nuclear rocket propulsion and nuclear electrical propulsion is imperative.

DR. FINGER BELIEVES May 13, 1964, will go into the records as the day on which a nuclear rocket reactor was first tested successfully at powers and temperatures which pave the way to use of the nuclear rocket in space flight.

If so, the day is indeed an important one. President Johnson already has called for a review of space missions which might be undertaken following the lunar landing. Nuclear rockets can play an important role in these, particularly when the requirement arises for manned planetary exploration. Even before then, however, it can be used to increase the payload capability of *Saturn V*, opening the way to more extensive lunar exploration and to operational bases on the lunar surface.

Taken in conjunction with the success a few days later of *Saturn* itself, the Jackass Flats run of KIWI-B4D made the month of May an important one. The years beyond—when automated and manned spacecraft are landing on Mars, when man pushes farther into space in the search for life outside this planet—will owe a debt to the determined group who carried out their own search in the Western desert into the troubles of KIWI-B4A.

William J. Coughlin

CAREER NEWS FROM HUGHES

Aerospace Divisions in Culver City, California

NEW AND CONTINUING PROGRAMS AND PROJECTS

F-111B PHOENIX Missile System
SURVEYOR Lunar Landing Vehicle
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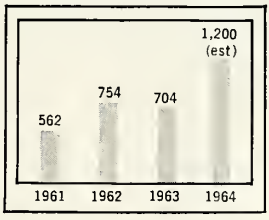
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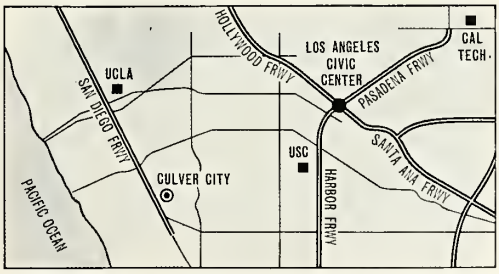
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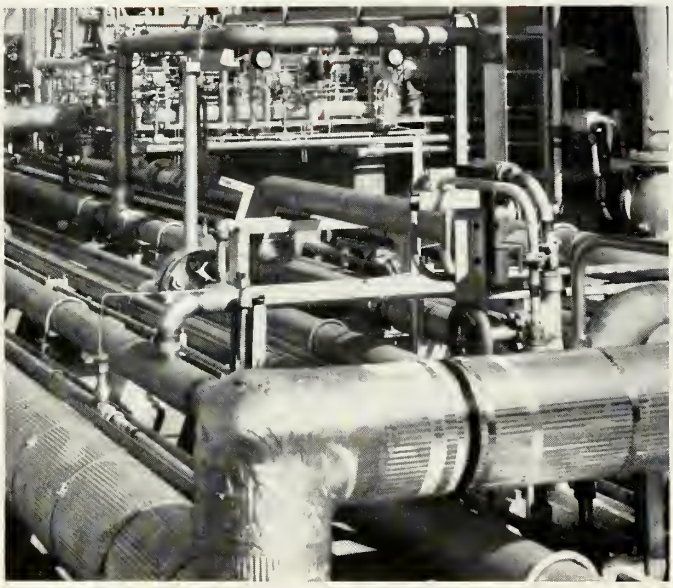
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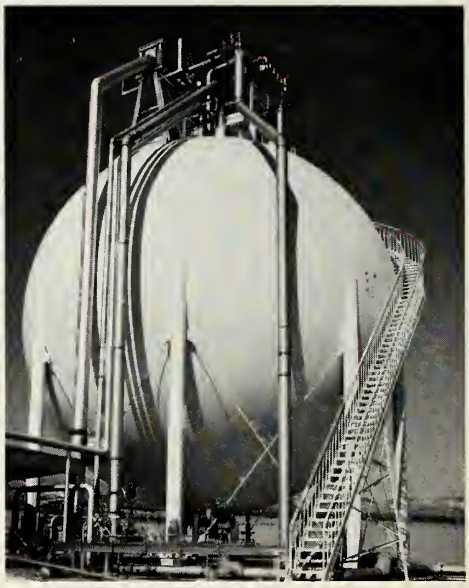
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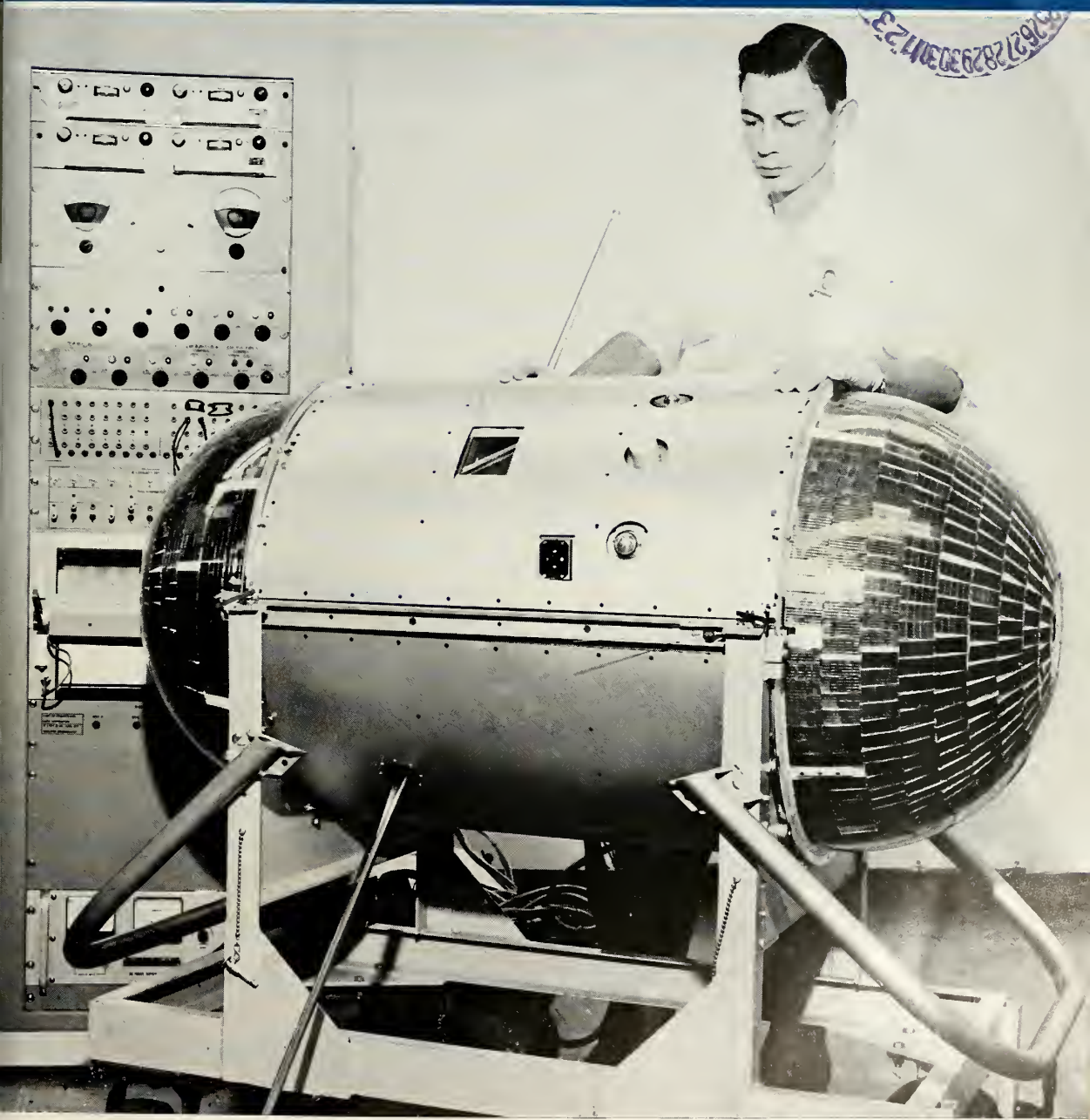


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JUNE 15, 1964

missiles and rockets

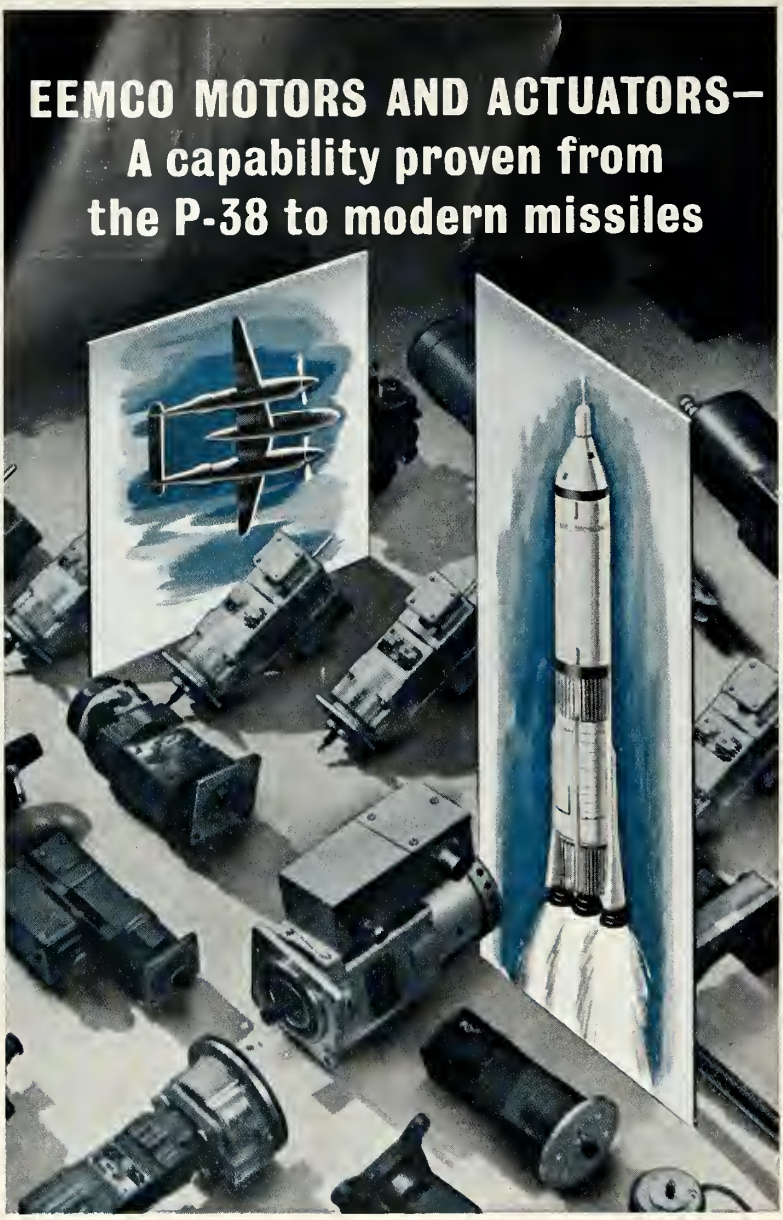
THE WEEKLY OF SPACE SYSTEMS ENGINEERING



GD/A's New SATAR Powered Satellite

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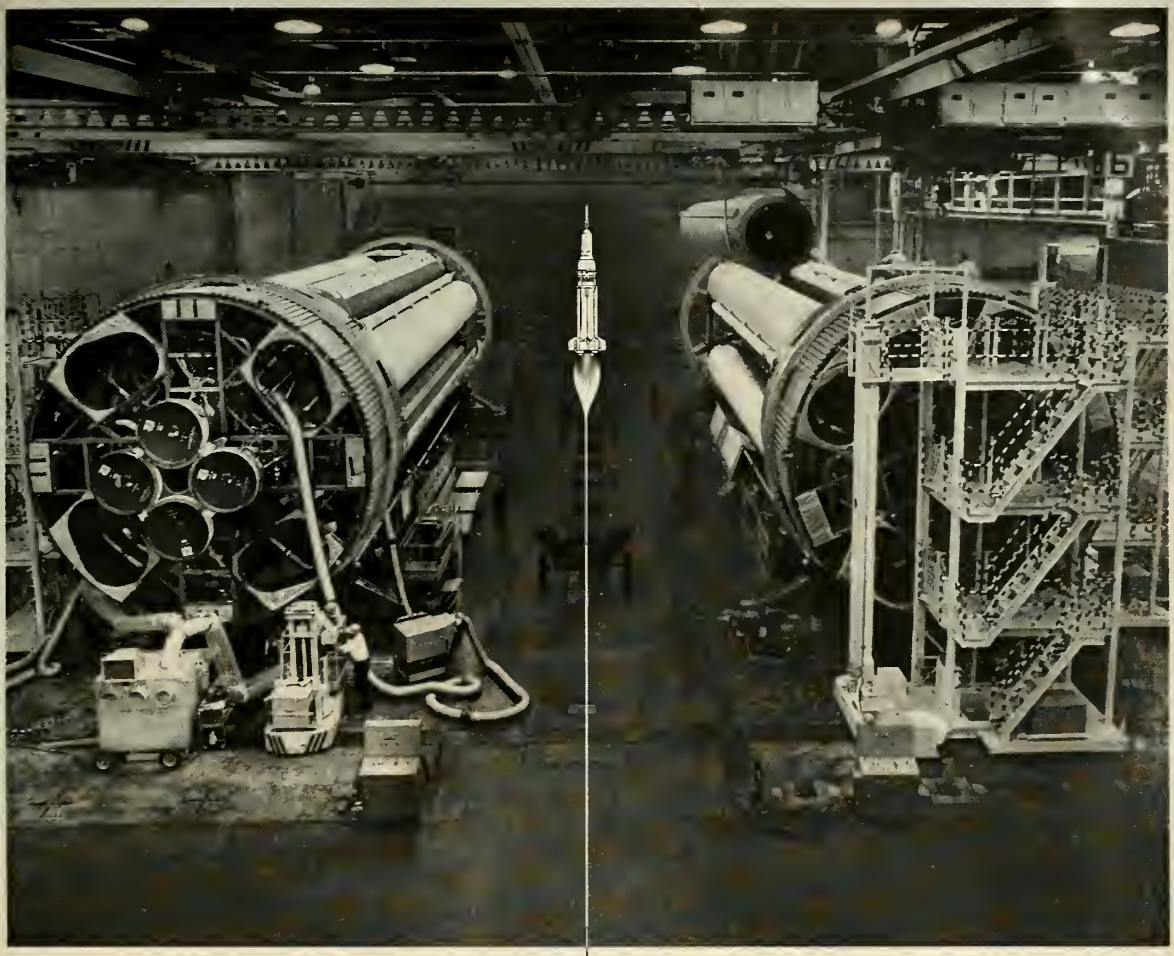
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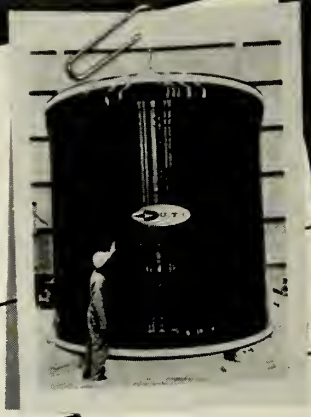
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Volume 14, Number 24 June 15, 1964

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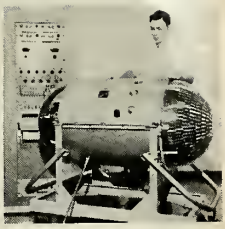
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THE COVER



Prototype Air Force SATAR satellite undergoes final preparations for series of simulated space environment tests at General Dynamics/Astronautics. SATAR is designed to transport scientific experiments economically into space on launch vehicles with extra capacity. *See story p. 24.*

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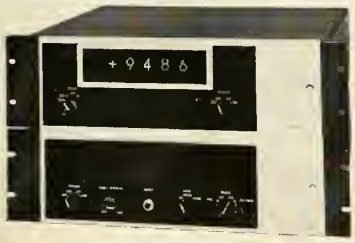
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letters

GE's TRAP V

To the Editor:

We appreciate the coverage of the TRAP I system contained in the article, "Range Instrumentation Calls for More Use of Aircraft, New Ground Systems" (M/R, June 1, p. 33). It should also be noted that the White Sands Missile Range TRAP V system, described in the same article, was provided and is operated by General Electric's Missile and Space Division for the USAF Ballistic Systems Division as a portion of the overall USAF-BSD TRAP program.

Richard L. Gulatsi
General Electric Company
Valley Forge, Pa.

Moon 'Foolishness'

To the Editor:

With respect to Rep. Louis C. Wyman's opposition to the FY 1965 House appropriation for NASA (M/R, May 25, p. 17):

He states that "the 1970 (manned lunar landing) target date is foolish." It would be a great deal more "foolish" if the Russians were to land on the Moon by 1970 and we had not. The Moon, being by far the nearest celestial body, is well suited for developing the engineering and technology for manned space flight in the solar system. These skills may be used for military and non-military purposes. The Moon is a very good launch site for missiles and spacecraft due to its ⅙ Earth gravity with an escape velocity of 1.47 mi./sec. compared with the Earth's 7.0 mi./sec. Also, the Moon has little or no atmosphere to hinder launchings.

Rep. Wyman states that we may not be able to use the *Apollo* equipment "if *Gemini* doesn't work." The possibility of *Gemini's* not working would seem to be pretty small, viewing Project *Mercury's* successes. Therefore, the possibility of not being able to use the *Apollo* equipment is small indeed, and the "long-lead-time advanced contracting" will save a great deal of time in Project *Apollo*.

D. W. Johnston
Washington, D.C.

Back to Petrograd?

To the Editor:

In comparing the name change of New Amsterdam to New York with that of Boulder Dam to Hoover Dam (M/R, March 9, p. 7), you display a surprising ignorance of the facts. Hoover Dam happens to be the original name of the dam in southern Nevada. The name was changed, for political reasons, during the New Deal binge of the Roosevelt Administration; the original name was restored during the Truman Administration. Those of us who want to retain the original name of Canaveral for the historic cape maintain that changing any well-established geographical entity for political reasons—be they vilification or hero worship—only too closely resembles the name changing that goes on in the Soviet Union whenever one dictator replaces another.

Norman Geidler
Falls Church, Va.

Stoking Our Fires

To the Editor:

It was interestingly *un*pleasant to see still another example of "The New Science Attitude" in The Countdown (M/R, May 18, p. 9) under the heading "ESP Communications Potential Raised." The attitude reported here seems much in keeping with present McNamara & Company attitudes against advancing our technologies before we are forced to advance by some Communist achievement. Now, thinking (or "anti-thinking," because only McNamara is allowed to think) has gone further.

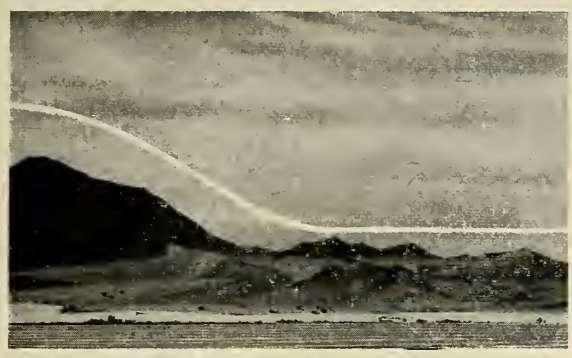
Instead of merely ignoring or verbally tearing down new ideas, so-called scientific programs apparently should be set up to "prove" that unusual notions are no good. The good Dr. Dagle should know better than to let his prejudices in advance of program results stand out as they did when he said (your quote) "no greater service could be performed than to show that these chimeras can only lead the scientist and layman alike down the primrose path to delusion." Closed-minded obstructionists have made such immature statements since before Columbus said the world is round. Any new idea is hard to understand, but we should approach it with an open mind—particularly when proposing a so-called "scientific" experiment. Perhaps no one knows what ESP is, let alone whether ESP is a reliable, reproducible process. However, any investigation into it should be both methodologically sound (scientific?) and motivated by a desire to gain useful information regardless of how the experiment turns out.

If Dagle's comment was a lone drop-of-water-on-the-ocean, it hardly would deserve notice. However, it seems to be part of a disturbingly clear trend toward pooh-poohing unusual approaches and setting up experiments to prove that new ideas are no good. This is a natural outgrowth of some of today's prevalent basic philosophies: 1) using highly structured project-type organizations for engineering work, 2) measuring the value of research by using measures more suitable to measuring the efficiency of mass-production manufacturing, 3) obliterating new ideas because they don't fit into situations covered by the operating organization's Rule Books, and 4) a belief that individuals owe loyalty to transitory organizational leaders rather than to strategic fundamental organizational missions.

Today, we are expanding upon basic scientific discoveries made decades ago, but what new basic work is being done to stoke the fires for the future?

(Name Withheld on Request)
Upland, Calif.

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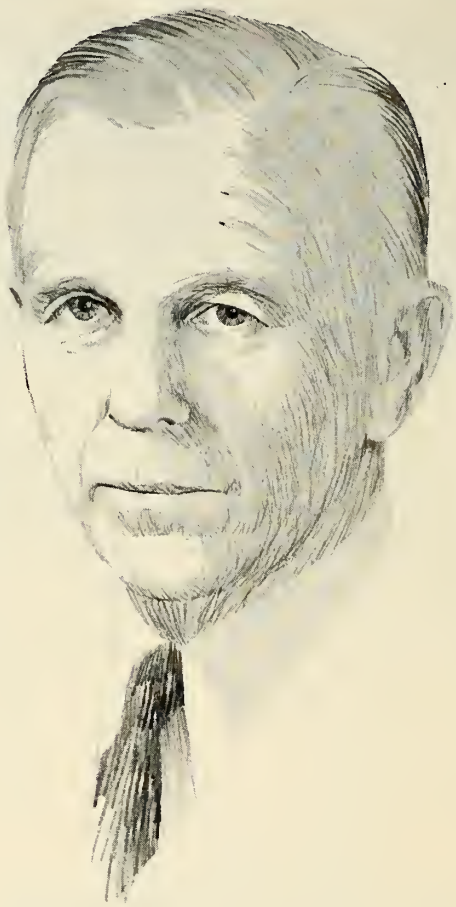


No other target missile system can duplicate the multiple mission capabilities of the Redhead/Roadrunner. It can travel lower and faster—more than Mach 1.2 at 300 to 500 feet above terrain. It will also simulate the enemy high in the sky—Mach 2.0 to 2.4 at 60,000 feet. The Redhead/Roadrunner is recoverable. Maneuverable. Reliable. Mobile. And zero length launched. Yet, even with all its advanced capabilities, it is exceptionally economical.

The Redhead/Roadrunner target missile system was designed and built for the U.S. Army by North American Aviation/Columbus Division. This multiple mission target missile is available for immediate delivery and service.

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4300 East Fifth Avenue, Columbus, Ohio



"The human race is so emotional . . ."

The year was 1939, and newly-named Chief of Staff George Catlett Marshall faced a mammoth task: preparing for war a country which thought itself insulated from the fires of Europe and Asia. "The human race," he remarked later, "is so emotional that good common sense seldom prevails in a great crisis." Fortunate it was for America and her allies that the good common sense of General Marshall prevailed, as he first built history's greatest military machine and then led it to victory.

But the soldier's responsibility did not end with one victory. Appointed post-war Secretary of State, he gave war-shattered Western European nations a second one . . . over poverty, hunger, and the communism which might have engulfed many of them but for his European Recovery Program. That is what *he* called it; most of us knew only of the "Marshall Plan."

By whatever name, it won him the Nobel Prize, and rightly. What tribute is equal to a man who brings unity, integrity, hope, and deliverance to nations at war *and* to a world at peace?

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The Countdown

WASHINGTON

No Minutemen Under Water

The floods in the area of Great Falls, Mont., last week have not affected the *Minuteman* site at Malmstrom AFB, Air Force officials report. All of the 150 missiles are still operational.

Centaur Launching Another Fortnight Away

Ground support equipment problems are forcing another two-week delay in the firing of *Atlas/Centaur 3*. The new date—June 30—was set when a LOX transfer unit malfunctioned during a tanking test at Cape Kennedy.

Northrop To Build Modified ARENTS for SSD

Air Force Space Systems Div. has awarded Northrop Corp.'s Space Laboratories a $725,000 contract for designing, developing and delivering the first of a series of satellites to be dubbed *MARENTS*—for Modified *ARENTS*. The four-year-old *ARENTS* (*Advanced Research Environmental Test Satellite*) began as an ARPA project, with General Dynamics/Astronautics selected to build three vehicles for launch in 1962. However, continuing slippage of *Centaur*, its scheduled booster, and other factors kept it from reaching flight-rated hardware status. Under SSD control, it will use the *Titan III* booster instead of *Centaur*. So far, no date has been announced for delivery of the first satellite or its launching.

Anti-Satellite Designation

DOD's anti-satellite program is designated officially as Program 437. This confirmation was received even though the Pentagon still refuses to acknowledge the existence of the device on Johnston Island.

Madre Located on Patuxent

A high military official revealed to MISSILES AND ROCKETS that the highly successful Madre over-the-horizon radar is located just a short drive from Washington at the Patuxent (Md.) River Naval Test Station. Not to be confused with the Patuxent Air Station, the Madre site is only a short distance from a major public beach and in clear view of the road along the Chesapeake Bay.

Action Nears on NASA, DOD Funding Bills

Senate leaders see speedy action now on the money bills which have log-jammed because of the Civil Rights debate. Now that cloture has been invoked—and assuming 10 days to two weeks to dispose of the bill—regular business could be resumed the week of June 22. The NASA authorization, already reported out of committee, will be taken up early. Defense appropriations probably will follow within three weeks.

Once More for the Boys in the Balcony

The House Military Operations subcommittee is almost ready to report on its feelings toward the military communications satellite program. Some members, however, have asked for one more day to question Dr. Eugene G. Fubini, Deputy Director of Defense Research & Engineering.

AF Still Troubled About NASA's ERC

One big reason Air Force officers are privately worried about having NASA's Electronics Research Center as a future neighbor of the service's sprawling electronics complex in suburban Boston is the special appeal the Center might have for some of the AF's top civilian scientists there. These men, frustrated by the fact that laboratory or department directorships in the service establishment are, with very few exceptions, filled by military men, might well be anxious to shift to NASA.

Scientist-Astronaut Recruiting Approaches

Dr. W. Randolph Lovelace, director of space medicine for NASA, says medical standards for the scientist-astronaut reservists probably will be set this summer. A call for volunteers is now expected in September.

INDUSTRY

Honeycomb May Absorb Apollo Shock

Apollo capsule designers are considering use of honeycomb material contained in aluminum cylinders to help absorb shocks transmitted from the Command Module's structural shell to the crew couches. Another type of honeycomb, formed by corrugated aluminum sheets stacked and bonded at varying angles, is being considered for placement between the heat shield and the crew compartment.

More Mars Craft Studies Let

The space agency is stepping up its drive to get two new spacecraft projects for Mars missions in 1969 and 1971. For the 1969 mission, Avco has been awarded a contract to study a capsule that would land on the surface; Lockheed Missiles & Space Div. will study an orbiter spacecraft. GE has been selected to study a *Voyager* spacecraft for a 1971 mission to be launched by a *Titan III-C* or *Saturn V* booster. At the same time, NASA has invited some 22 firms to submit proposals for preliminary design of an *Automated Biological Laboratory (ABL)* to be carried on *Voyager*. Bids for the one-year study are due June 29.

Army Contracts for New Rockets

Army's Missile Command at Redstone Arsenal has awarded a contract to Emerson Electric Co., St. Louis, for design, development and fabrication of an undisclosed number of solid-fueled, unguided, test rockets. The rockets will use "spin-on-rail" launch stabilization techniques. Emerson is a major contractor on the *Honest John* missile, which also uses the SOR technique.

Minuteman Mark 12 Penaids Funded

General Electric's Re-entry Systems Dept. in Philadelphia, prime contractor for the new Mk 12 re-entry vehicle for the *Minuteman II* ICBM, has awarded parallel contracts for study and preliminary design of penetration aids for the vehicle to two Long Island, N.Y., firms—Lundy Electronics & Systems, Inc., of Glen Head, and the Leesona Moos Laboratories in Great Neck.

INTERNATIONAL

French Cultivate Research Cooperation

French government (C.N.E.S.) authorities are stepping up cooperation with both India and Pakistan, as well as Argentina. *Belier* and *Centaure* probe rockets will be sold or manufactured under license as part of this program, and technicians will be exchanged. Sud-Aviation, meantime, has been selling sounding rockets to West Germany.

The Missile/Space Week

Douglas To Uprate Delta

The space agency has asked Douglas Aircraft Co., Inc., to uprate the second stage of the *Delta* booster.

Diameter of the stage's fuel tank will be enlarged from 32 to 54 in. This will increase the stage's burning time from 160 to 400 secs.

Total cost of the uprating of eight *Deltas* now being purchased by the space agency from the firm is $6 million. The new work will increase the total cost of the booster to $15 million.

The uprated vehicles will be used in the *Biosatellite, Pioneer* and meteorological programs.

Some of the uprated second stages will also be combined with the *Thrust Augmented Delta* (*TAD*) with its two solid strap-on motors.

When used with *TAD*, the second stage will increase the payload from 1,000 to 1,200 lbs. in low Earth orbit.

DOD-ComSat Decision Due

Dept. of Defense use of the Communications Satellite Corp.'s medium altitude communications satellite concept for military transmissions has been termed a "70% probability" by Assistant Secretary of Defense Eugene G. Fubini.

A final DOD decision on the matter was felt to be imminent the middle of last week.

Aerojet Now in Shipbuilding

The recent acquisition of the Gibbs Shipyards, Inc., Jacksonville, Fla., by Aerojet-General Corp. (M/R, June 8, p. 43) will provide an outlet for various technologies already existant within Aerojet.

Among the possible activities slated for the shipyard are extensions of Aerojet work in the fields of propulsion, new structural materials, life sciences, underwater developments and the construction of 26 destroyer escorts over the next few years. Aerojet has submitted a bid for the last item to the Navy.

In addition, the shipyard is termed vital by a company spokesman to exploit the newly proposed program on deep submergence, which will be funded in excess of $500 million over the next five years.

Aerojet is also experimenting in the conformal array sonar field and a sonar system with a range four to five times that of current systems is in the works. This development is in conjunction with Technological Research-General, Inc., 16% owned by Aerojet.

The price of the transaction was not disclosed, but the seller, America Corp. of N.Y., acquired the facility from the Gibbs family a year earlier for $7 million.

Improved ASSET Detailed

A 10-ft. long, delta-winged glider —capable of travelling almost completely around the world—has been revealed as the goal of the improved *ASSET* program. Speaking to a group of touring newsmen, Lt. Col. Sherman L. Hislop, an Advanced Planning Officer at the Air Force Space Systems Div., said that the vehicle should be ready to launch within the next two years.

It was further learned by MISSILES AND ROCKETS that the follow-on *ASSET* will have a lift-to-drag ratio of 1.2 versus 1.0 for the present *ASSET* and will re-enter at speeds up to 25,000 fps. The craft would have a wingspan of about 4 ft. and will weigh 1,600 lbs. The present *ASSET* program includes two vehicles, weighing 1,100 and 1,200 lbs., and capable of re-entry speeds of 18,000 fps.

Air Force officials consider the follow-on vehicle far more realistic for eventual development of a winged, maneuverable re-entry vehicle for manned flight. Launch of the improved *ASSET* would be from the Eastern Test Range at Cape Kennedy, with the landing site on the West Coast of the U.S. However, Air Force officials stress that this does not necessarily mean that the vehicle would land in California.

Secretary of Defense Robert S. McNamara promised an expanded *ASSET* program last December when cancellation of *Dyna-Soar* had been announced. However, until now, no details of the follow-on program had been revealed. Air Force officials in Washington declined to comment on the Hislop statement and pointed out that there was no approved program for the expanded *ASSET*.

One *ASSET* vehicle was launched last September 19 from Cape Kennedy and, although 130 channels of information were telemetered to the ground during flight, the shot was only a qualified success because of the failure to recover the vehicle. Several more flights are scheduled from the Eastern Test Range during this year.

Shots of the Week

Britain launched its *Blue Streak* booster from Woomera, Australia, June 5. Primary objectives of the flight were reportedly achieved despite premature shutdown of engine thrust, which caused the booster to fall short of its target speed and range. Top speed achieved was 6,477 mph—2,000 mph less than intended—and the vehicle fell 209 mi. short of its target. The launch was the first in a series of nine scheduled for the ELDO program. *Blue Streak* will form the main stage booster for the three-stage ELDO launch vehicle, with the second stage slated to be a French *Coralie* booster. West Germany will provide the upper stage, an as-yet-unnamed rocket under development. All three stages will provide boost for the first ELDO space launch of an Italian satellite in 1966.

- The Air Force used a *Scout* booster to launch a secret satellite from Pt. Arguello, Calif., on June 4. Purpose of the shot was not revealed.
- The Air Force launched a satellite of undisclosed type aboard a *Thor-Agena* booster June 5 from Vandenberg AFB, Calif.
- The Navy fired two *Polaris A3* missiles June 8 from the submarine USS Daniel Webster, submerged off the coast of Florida. The shots were the fifth and sixth consecutive successes for the missile.
- The Soviet Union launched the 32nd satellite in the *Cosmos* series on June 10, according to the official news agency Tass. The series began in March, 1962.
- NASA launched an *Aerobee* rocket in a meteoroid penetration probe on June 10 from White Sands Missile Range, N.M. The vehicle performed successfully, and the payload was recovered.

NLRB Acts To End Strike

Union members were still picketing entrances to Cape Kennedy the middle of last week as National Labor Relations Board mediators appealed to Federal District Judge George Young for an injunction to halt them.

The pickets, members of the Brotherhood of Maintenance of Way Employees, were renewing an earlier protest over the use of a Government-owned spur into the Merritt Island

Launch Area by the strikebound Florida East Coast Railway. Their picket lines resulted in 3,854 of the Cape's 4,607 workers staying off the job last Tuesday.

In spite of almost total work stoppage on prime MILA construction and work on the *Titan III* complexes 40 and 41 at the Cape, however, several other projects have continued without absentees. These include alterations to Pad 14, slated to launch the *Atlas-Agena* target vehicle for *Gemini*, MILA utilities for static test stands, cable terminal building at MILA and a fill project for Pad B of Complex 39.

Correction

In its two-part series on the *Nike-X* program (M/R, May 18, p. 14; May 25, p. 14), MISSILES AND ROCKETS erroneously reported that the *Sprint* missile would use the same jethead principle used by the *Nike-Zeus*. Defense officials commenting on the series pointed this out as the only error in fact in the articles.

Sprint, they admit, does have considerable maneuverability in the atmosphere, but the means used to achieve it is considered classified.

IBM Lauds SA-6 Guidance

Saturn SA-6's second stage ST-124 guidance was termed "very satisfactory," by International Business Machines Corp., whose modified ASC-15 digital guidance computer computed *SA-6* guidance command.

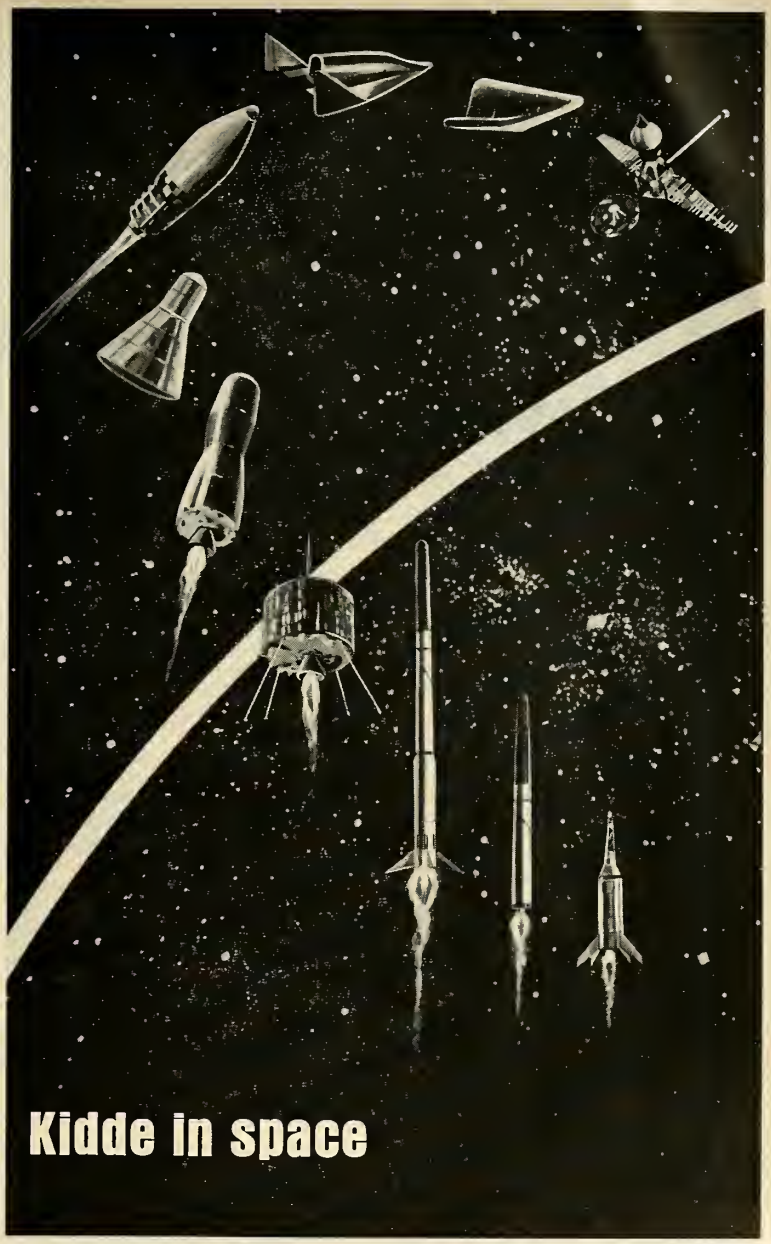
IBM says that at the initiation of guidance (S-I/S-IV separation plus 18 sec.) the system had to correct the abnormal flight conditions caused by premature cut-off of one of the S-I engines and by higher-than-expected performance of one S-IV engine.

The firm reports that the following maximum command angles were generated by the guidance system to correct the abnormalities: X = 2¾ degrees (cw viewed from tail); Z = 3¼ degrees (nose up); and Y = 5 degrees (nose up).

Sergeant Tests Set

The Army has scheduled test firings of the *Sergeant* tactical missile this summer on the British Hebrides Islands missile range.

The U.S. missile battalions will be airlifted to the range from stations in Germany during July and August and British Army units will provide some personnel to support the exercise.



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Zuckert, Bleymaier disclose . .

AF Widens Manned Flight Role

Air Force astronauts may join NASA Gemini, Apollo crews; 100 officers to staff Integrated Mission Control Center

by Warren Burkett

HOUSTON—The Air Force is sharply increasing its participation in NASA's manned space flight program and Air Force astronauts may be assigned for training as crew members on some *Gemini* and *Apollo* flights.

It has been learned that 100 Air Force officers will help to staff the Integrated Mission Control Center at the Manned Spacecraft Center. This will just about double the number of Air Force personnel serving with the space agency.

At the same time, Brig. Gen. Joseph Bleymaier, deputy chief of staff of the Air Force Space Systems Div. for manned space flight, indicated that Air Force astronauts may fly aboard the *Gemini* and *Apollo* spacecraft with the NASA crews, which already include some Air Force pilots assigned to NASA.

Details of the expanded civilian-military cooperation role and new information on the *Titan III/Manned Orbiting Laboratory (MOL)* program were divulged in interviews following speeches to the Texas wing of the Air Force Association by Secretary of the Air Force Eugene Zuckert and Bleymaier.

Zuckert said Air Force staffing was to expand far beyond the 100 officers now assigned to NASA work and that he and Dr. Hugh L. Dryden, deputy administrator for NASA, were working out specific job assignments. Twelve positions have been identified and agreed upon so far, Zuckert said.

● **Agreement by September**—Originally, only about 50 new jobs were under discussion, but NASA says this has now been expanded to 100. Staffing the IMCC around the clock will require nearly 700 persons spread over three shifts. Officials of the Air Force said the negotiations between NASA and the Air Force should conclude by September.

"It's really just a matter of timing on our part," said Bleymaier, about putting Air Force astronauts aboard *Gemini* and *Apollo* flights.

Junior executives of the space center were less convinced it would be this simple. On one hand, the *Gemini* flight schedule and objectives seemed already too frozen to permit Air Force men easy entry into the training programs; in the *Apollo* program, the situation was described as "too fluid and changeable" for identification of Air Force missions.

Both NASA and SSD sources said no formal discussion had been held on the subject.

Bleymaier said the expanded *Mercury* Control Center at Cape Kennedy would serve the Air Force's needs in early *MOL* flights. The IMCC at Houston offers the only control center equipped to handle a rendezvous mission, he conceded, if this requirement accrues to the Air Force.

● **Combined staff advantages**—It is apparent that there are several mutual advantages in a combined staffing of the Integrated Mission Control Center. Obviously, the Air Force would gain by training flight controllers in manned space operations and tracking.

Bleymaier pointed out that the Air Force has a wealth of men trained in the tracking and identification of unmanned objects orbiting the Earth through its own satellite tracking center on the West Coast.

Assignment of Air Force personnel to the IMCC would relieve a personnel shortage that MSC flight chiefs have described as serious. This shortage resulted in part from the ceiling put on NASA personnel by Congress.

The Air Force also would be involved in Project *Apollo* in case the *Extended Apollo* should win the ultimate *MOL* role (M/R, June 8, p. 14).

● **AF activity detailed**—Gen. Bleymaier also disclosed that:

—Flight crews for *MOL* will come from the nine *Dyna-Soar* pilots and men now at the Aerospace Pilot School at Edwards AFB, Calif. It is expected that 15 to 18 pilots will be used initially.

—The Air Force will begin discussing specific flights aboard *Gemini* and *Apollo* when Secretary of Defense Robert S. McNamara gives the go-ahead for production of *MOL* hardware. McNamara's approval of specific *MOL* plans is due before the end of the year, Bleymaier said, with the possibility of picking a contractor in May, 1965.

—Seventeen *Titan III-C* launches are now planned. Two of them will be allocated to the manned *MOL*, Bleymaier said; these two originally would have carried the now-dead *Dyna-Soar*.

Five of the 17 *Titan III* shots will fly without the solid motors; payloads of about 6,000 lbs. will be carried into orbit, beginning with the first shot this summer. Payloads will contain scientific or engineering research projects, said the general, and not ballast. NASA experiments will be accommodated.

—Five of the payloads will contain the *ARENTS* package. These shots should begin with the second firing of the *Titan III-A*, the second test of the core rocket without the strap-on solid boosters.

—The *Titan III* program includes a five-step progression farther out into space with each shot to qualify the booster as a man-rated, standard space launch vehicle. The five steps: low Earth-orbital, high Earth-orbital, parking orbit and re-entry, escape velocity trajectory and a synchronous orbit. ■

Plus cloud-cover photos . . .

U.S., Russia Agree to Swap Data On Space Biology and Medicine Work

THE U.S. and the Soviet Union have agreed to exchange information in the areas of space biology and medicine.

A new agreement extending space cooperation between the two nations was announced by Dr. Hugh L. Dryden, deputy NASA administrator and chief U.S. negotiator in space pact talks with the Russian representative, Academician Blagonravov.

The latest discussions were held in Geneva during the meeting of the Scientific and Technical Subcommittee of the United Nations Committee on Peaceful Uses of Outer Space.

Dryden called the agreement "a very small beginning in the area of manned spaceflight." He added, however, that after private discussions with the Soviet negotiator, he believed that nothing of major significance was brewing in that area of cooperation.

Under terms of the new agreement, each nation will appoint an author to compile the current work being done in the area of space biology and medicine in his own country. The two books—which will also include a projection of the future work to be done—will be published together in a single volume. The data will then be made available to the rest of the world. It is expected that the reports may take up to two years to prepare.

● **Photo swap**—Dryden also said that the two nations will exchange cloud-cover photographs taken by weather satellites beginning in 1965.

The time schedule hinges on the launching of a Russian satellite now some four months behind schedule. The Russians originally reported that their satellite would be ready by about mid-1964.

The cloud-cover pictures will be transmitted on a communications link extending from Moscow through Poland, Berlin, Frankfurt and London to New York and Washington. The two nations will split the cost of the link, which is estimated at $250,000 per year. Other interested nations will be permitted to share in the hook-up on a receive-only basis.

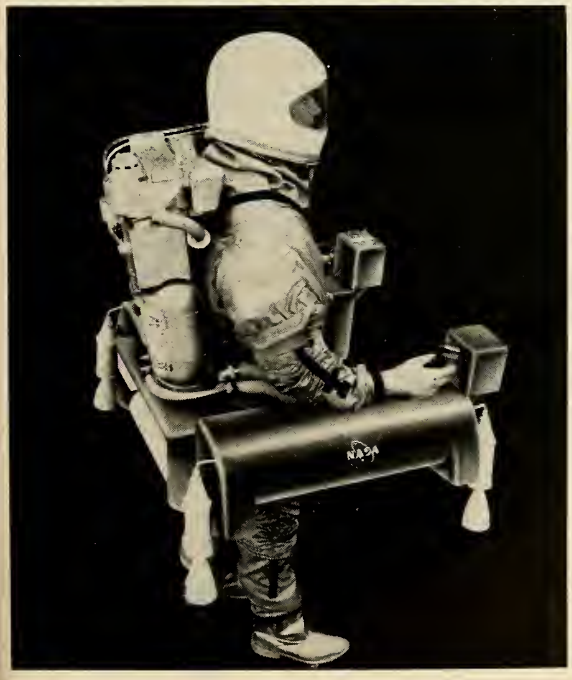
The NASA official said that the next step in space cooperation may be the exchange of information about the lunar surface, including pictures. Noting that the United States has always been interested in this area, he indicated that the subject may be discussed at the next meeting of the two negotiators.

● **Benefits**—In discussing which nation will gain most from the exchange of biology and medical information, Dryden noted that while the Russians already have much of the U.S. data available to them, the new report will put it in a more readily assimilated form.

The Russians apparently are interested in closed ecological systems in which they believe the U.S. state of the art is ahead of theirs.

Dryden added that since the two authors will be under pressure to make a good showing, the psychological pressure may result in a more complete account of Russia's work in the area.

Regarding future cooperative communications experiments, Dryden said "it was decided by the Soviets that they did not wish to discuss at this time further measurements with the *Echo* balloon. This in part, I suppose, is because suitable experts were not in Geneva. They expect the *Echo* to be up for quite a while and decided to carry on by correspondence so far as further tests are concerned." ■



One-Man On-the-Moon Propulsion

MOCKUP of lunar configuration of one-man propulsion system being built by Hamilton Standard Div. of United Aircraft Corp. for NASA's Manned Spacecraft Center. Device will lift, lower and rotate an astronaut, as well as move him forward and backward.

Arms Control Inspection Tests Set

Strategic delivery systems first to come under scrutiny in joint Defense Dept., Arms Control and Disarmament Agency program

by James Trainor

FIELD TESTS of the inspection and verification procedures inherent in a negotiated limitation on strategic delivery vehicles will be initiated at selected aerospace contractor plants "within the next few months."

A program outlining the scope of the field tests is in final stages of preparasound practical basis for U.S. disarmament Agency and is expected to be approved for implementation within the next 30 days.

These tests are part of the joint Department of Defense/ACDA Project Cloud Gap, which is designed to give a sound practical basis for U.S. disarmament proposals and to test the efficacy of USSR arms-limitation suggestions. In the more formal jargon of the government, the purposes of Cloud Gap are:

—to acquire practical experience in the operation of a field inspection system;

—to evaluate specific proposed inspection techniques and equipment;

—to collect data concerning the effectiveness of such inspection units in monitoring military activity and assessing its significance in terms of potential military threat;

—to demonstrate the feasibility of a military activity monitoring system.

The program, according to an ACDA official, has "sort of been under way for two years." The major activity in Project Cloud Gap, however, has been concentrated in the last eight months. In November, 1963, the first field test was conducted at Fort Hood, Texas. A basic experiment, the Ford Hood exercise was limited to determining the capabilities of resident inspection teams to detect and verify the amounts and types of armor present on the post.

The second test took place in conjunction with the U.S. Strike Command's Desert Strike exercise, May 17-30. This was the first of a series of proposed Cloud Gap tests concerned with inspection of deployed forces, the levels of such forces and their significance.

● **Delivery vehicle program**—Although ACDA feels that controls on strategic delivery vehicles must apply to both the research and development and production phases of weapons systems acquisition, the initial Cloud Gap program will concentrate on the latter.

Bendix Systems Div. of the Bendix Corp. has completed a study on how to police limitations on production of strategic delivery vehicles. This study extended not only to inspection and verification at declared production facilities but also to ferreting out undeclared sites.

Based on this study and inputs from experts in foreign manufacture, production facilities have been identified in the U.S. for the Cloud Gap test. These facilities were picked partly on their resemblance to similar plants in other countries. Agreements have been concluded with these "near-facsimiles" to allow Cloud Gap teams access.

Key to monitoring the production of strategic delivery vehicles, in the opinion of Cloud Gap officials, is inspection and verification of a few critical long-leadtime items peculiar to weapons development. Rocket motors are one of the principal items amenable to inspection, with missile airframes and guidance systems (to a lesser extent) also listed as possibilities.

Basically, the inspection and verification system for declared production facilities would involve keeping track of a rocket motor from its fabrication, through final assembly into a launch vehicle and finally its expenditure either in an operational firing or a stockpile.

● **Broad inspection needed**—This procedure of inspection and vertification from fabrication through final assembly to final disposition is a *sine qua non* for an agreement on limitations on production of strategic delivery vehicles. Inspection of stockpiles or launch sites would not be sufficient, arms control experts stress.

To start in the next several months, the strategic delivery vehicle field test program is expected to provide inputs, based on actual experience, to the current Geneva Disarmament Conference. On April 19, the U.S. proposed a "freeze" on the production of nuclear delivery vehicles—covering land based missiles with ranges in excess of 621 miles and sea-based systems with a range of 62 miles or more.

Present inventories, under the plan, would not be subject to inspection, but production facilities and launching complexes would come under the agreement.

● **Hidden sites**—Not included in this particular field test, but planned as a later exercise, is the problem of locating and identifying clandestine production facilities.

Resident inspection teams are used for declared sites, but aerial reconnaissance or ground mobile teams would have to be used to locate undeclared facilities.

Once the site is located, then an even more complex problem must be faced in negotiating for the right to enter the plant. This involves, according to ACDA officials, the very real problem of the legal right of privacy versus the right to enter under an arms control agreement.

● **Cloud Gap particulars**—Under the summary program outline for Cloud Gap operations in the period 1965-68, the program will peak in FY '66 and continue at a lower level for the remainder of the period. Actually, ACDA officials expect the program to continue indefinitely but decline to look more than five years ahead.

Funding in FY '64 included $1 million in the Advanced Research Projects Agency for Cloud Gap with another $1 million planned for FY '65. These funds are primarily for payment of the support contractor—Space and Information Systems Div. of North American Aviation, Inc.—which is responsible for data reduction of information from Cloud Gap field tests.

Air Force has $2 million in its FY '65 budget for the program. According to a DOD official, however, the Air Force acts only as a "banker" for the money, expending it as Cloud Gap officials dictate. ACDA is thought to have more than $660,000 allocated to the program in FY '65. ■

Technical Information Survey Aimed At Establishing RDT&E Data Needs

SOME VERY BASIC questions are being asked of Defense Department Research, Development, Test and Evaluation (RDT&E) personnel in a comprehensive survey of technical information acquisition and use as related to specific development tasks.

An in-house sample of 1,300 RDT&E specialists out of a total population of 35,000 has been selected for interviews by the Auerbach Corp., which is conducting the survey for DOD.

With the rate of scientific knowledge approximately doubling every 10 years, DOD is attempting to discover what materials are actually used by RDT&E personnel in the accomplishment of a specific task as well as those materials that working engineers and scientists need, but don't necessarily have, to do a particular job.

The magnitude of the technical information challenge is shown by the fact that DOD spends $60 million a year on in-house information materials, and that DOD contractors spend $140-240 million for RDT&E information alone.

● **Determining needs**—Results of the survey are expected to provide a basis for future experiments to improve the effectiveness of information flow to the working level. By determining what people actually use in accomplishing their job and what they need to do a better job, DOD hopes to be able to strengthen widely used sources, identify marginal areas and perhaps eliminate some sources not widely used. Unfilled needs of working personnel will also be uncovered.

Headed by Walter M. Carlson, director of technical information of the Directorate of Defense Research and Engineering, the program will consist of a two-hour interview with each of the individuals in the sample. This interview will pick a specific task, preferably the last completed assignment accomplished by the interviewee and will concentrate on the information required and received to complete the job.

A specific piece of information required to do the job is termed, in Auerbach parlance, a "chunk." The interviewee is asked what chunks of information he used and is asked to produce them to avoid responses predicated on what the interviewee might expect should be his response.

These chunks can come from oral sources, handbooks or personal files. The only important criterion is that the individual used the information in his work.

So far, the Auerbach Corp. has interviewed 176 individuals and has contacted some 48 others. All interviews are to be completed by October, with an analysis of the results to be submitted to DOD by November.

● **Speeding the program**—Carlson said that he has been discussing the survey with the major associations in the industry—National Security Industrial Assn., Electronic Industries Assn. and Aerospace Industries Assn. These associations reportedly will make a decision on whether it is appropriate for them to call the program to the attention of their membership or perhaps to conduct a similar survey themselves.

A decision by an association or company to conduct the survey would, in effect, telescope the time required to complete the program, since Carlson admits that DOD will likely fund such surveys of industry following the November completion of its own program.

Cost of the program will be $400,000 including $100,000 spent on a pilot survey and in determining the form of the questionnaire.

One of the chief limitations of the program is that it does not attack the "current awareness" problems in which the engineering and scientific person reads periodicals and trade magazines to keep abreast of areas that may not be directly applicable to his job. "This is beyond us" at the moment, Carlson admits.

Another survey limitation is the fact that it only covers RDT&E personnel and the task-related information they use. Other parts of the technical information "glut," such as engineering drawings, specifications, etc., will not be covered nor the technical information requirements of procurement and maintenance personnel. ■

Meteoroid Probe Is Assembled



INFLATABLE meteroid penetration probe is assembled and pressure-tested at Space General Corp., El Monte, Calif., contractor to NASA for the probe, shown here upside down. Launch was successful. *See "Shots of the Week," p. 10.*

While ComSat Corp. makes new awards . . .

Planners Eye Comsats for the 1970's

'Parochial' U.S. attitude scored; ability to serve less developed regions seen as long-range criterion; details of contracts to AT&T/RCA, STL/ITT and Hughes

by Michael Getler

PHILADELPHIA—The first global commercial communications satellite network still sits largely on the drawing board, but several industry planners already are turning their attention to second-generation hardware systems and, perhaps more importantly, to the next round of potential users of this new medium.

First-generation systems, such as those now under study by the Communications Satellite Corp. (CSC), are aimed primarily at satisfying the heavy trunk traffic between Western Europe and the Americas. There is no argument that this traffic demand creates the initial economic impetus for satellite communications.

However, many experts believe that the real test of a truly global system operating in the 1970's will be whether it can bring these services economically to less developed regions. Planners point out that many of these areas, though less sophisticated technically, represent vast centers of commerce with immense communications requirements which could be fulfilled by regional participation in comsat systems. "Because of unfamiliarity with these places," reports A. J. Lipinski of Lenkhurt Electric Co., Inc., "it is easy to underestimate the amount of non-defense or non-govcrnment traffic."

Lipinski, speaking at an evening panel session of the International Symposium on Global Communications held here last week, also said that as far as he knew no organization was now looking at this problem from a global standpoint—studying such things as traffic types and quantities, switching problems, and peak-traffic timing patterns.

● **Refinement sought**—In order to solve the regional and "small country" problem, multiple-station satellite-access operation will have to be refined beyond that of initial networks, according to engineers here.

ITT Federal Labs' Walter L. Glomb told the audience that second-generation multiple-access schemes will have to meet both small and large traffic requirements, and work with both small and large ground facilities and various forms of modulation through a single spaceborne system. The system will also have to be very efficient in handling digital traffic, which he believes will constitute a major portion of the business in the '70's.

While several multiple-access schemes have been proposed and are under development—including FDM-FM, SSB-FM, TDM, and RADAS—the feeling was that each of these systems still manifested some form of inefficiency in terms of either hardware, power, or time utilization. To extend comsat use into less developed regions, as one engineer states, will require new access schemes "to avoid charging small users unfarily because they are forced to use the satellites inefficiently."

It also was suggested that good-quality satellite communications, though below established international standards, might provide a workable solution for the small user.

Lipinski raised the further problem, in view of the expense involved, of finding some way to test these new schemes so that they will be developed by the time the market becomes available.

He cautioned against "the parochial attitude of the U.S." in its proposals for systems in which European countries will be asked to participate. "The more exotic system we have," he said, "the more trouble we'll have selling it. As soon as the talent abroad improves in this area, the Europeans will play a bigger role in defining systems."

Lipinski drew an analogy to the international air transport field, where growth of the aviation business into all corners of the world has created very difficult working relationship problems in terms of approving international systems.

A panelist from RCA, Dr. Richard Marsten, citing component problems which are likely to expand if comsat usage expands, called for more attention to development of reliable unpressurized broadband spaceborne transmitting tubes able to put out 100-250 watts of RF power at efficiencies of about 40%. He also noted the problems of broadband non-selective limiting.

ComSat Corp. participation in the three-day meeting here was limited in comparison to original plans, primarily due to the issuance of the Corp's stock

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for public sale earlier in the week. During the stock's pre-filing and registration period, and for a period after the initial offering, the stock's prospectus is considered the selling document, and officials are reluctant to stray far from the material presented in it.

● **ComSat awards**—In Washington, however, the company took another step toward defining the system it hopes to have operational by late 1966.

CSC notified FCC of its intent to award three six-month engineering design contracts—to an American Telephone and Telegraph/RCA team ($1,079,600 for AT&T and $1,300,000 for RCA); a Space Technology Laboratories/International Telephone and Telegraph ($1,265,000 total); and a $100,000 study contract to Hughes Aircraft Co.

● **Random approach**—The AT&T/RCA team will study a random-orbit medium-altitude system composed of 18 satellites each with an initial capacity of 530 high-quality voice circuits when used with Earth stations of the types at Andover, Maine, or Pleumeur-Bodou, France. The satellites would each contain two active repeaters and be placed in a 6,000-mi. circular polar orbit. Each repeater would effectively radiate about 4 watts and operate between 5,925 and 6,425 mc for the "up" link and 3,700-4,200 mc for the satellite-to-ground link.

The AT&T/RCA proposal, M/R has learned, calls for launch of two satellites at a time aboard a Douglas Aircraft Co. Super (or Improved) *Delta* launch vehicle. This consists of an augmented *Thor* first stage, an Aerojet-General second stage similar to that used on the *Delta* but with increased tank volume, and a solid-propellant *X-258* third stage. However, it is also known that further discussions will be held to explore possible performance gains for this vehicle by substituting a *Surveyor* motor for the *X-258*.

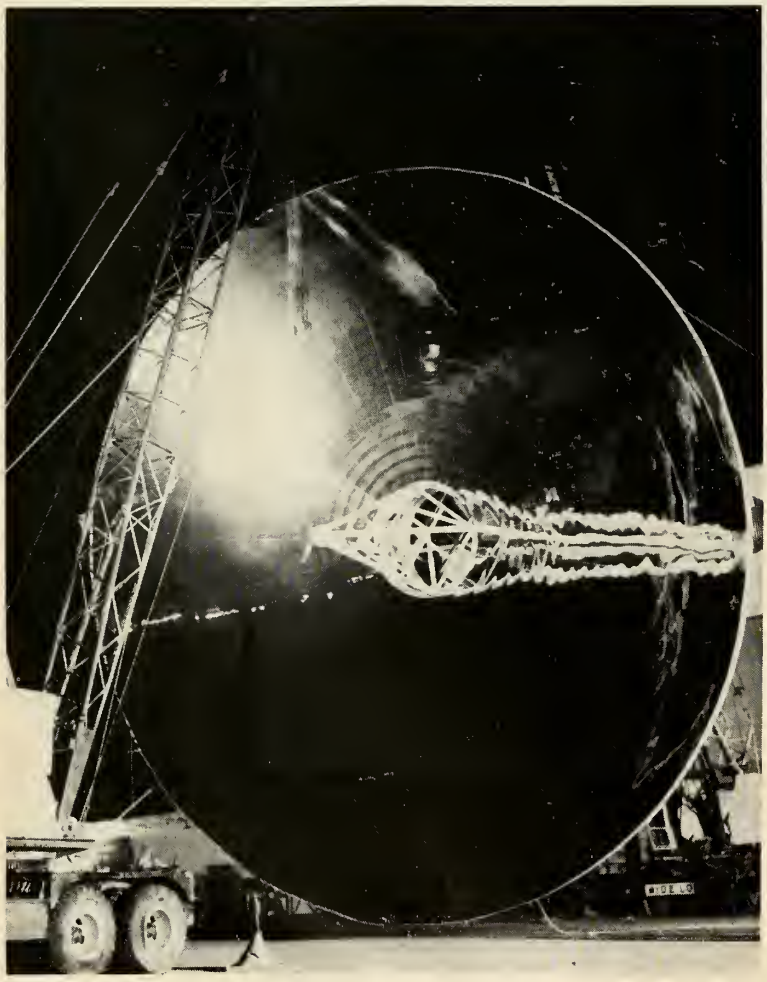
The *Surveyor* motor, made by the Elkton (Md.) Div. of Thiokol Chemical Corp., is a solid-propellant powerplant with maximum thrust of 9,000 lbs.; its total weight is 1,368 lbs., of which 1,230 lbs. is propellant.

An interesting part of the CSC specifications to industry for the medium-altitude system is the requirement for a "guarantee formula" at the end of the six-month study, providing for penalties and incentives, based upon the actual service life in orbit which can be attained by these satellites. The AT&T/RCA proposal states that a ten-year satellite life can be designed, however, due to the timetable of the corporation, "for guarantee formula purposes a five-year objective was established."

Under the joint AT&T/RCA agreement, AT&T will only participate in the six-month study and will not take part in any follow-on hardware contracts in the event CSC chooses the medium-altitude random-orbit approach. RCA will be eligible for the hardware contract.

● **Controlled system**—The STL/ITT team will also study a medium-altitude system, but its design will incorporate control apparatus for satellite positioning and spacing in orbit relative to other satellites. Fewer satellites—about 12—are envisioned for global coverage with this approach. However, satellite complexity is increased due to the control requirement. This system will operate in about a 6,000-mi. circular orbit. Gravity-gradient stabilization will be an integral part of the satellites, each of which is intended to provide approximately 800-1,200 voice chanels and exhibit a 3 to 5-year lifetime.

● **New syncoms**—The Hughes contract is basically for a study and preliminary design of the next generation of synchronous-altitude comsats, beyond the scope of Hughes' already heavy involvement with CSC for the experimental *"Early Bird,"* or HS-303 (CSC designation) to be launched next spring. The new system under study is intended to have at least 600 duplex voice channels or, as an alternative, two television channels. Hughes will also study improved and simplified directional antennas. ■



Night-Traveling Sunshine Collector

BECAUSE its beam can set fire by picking up a flash of sunlight, this 45-ft.-dia. solar concentrator recently had to be moved at night under floodlights from a building at Goodyear Aerospace Corp.'s Litchfield Park, Ariz., plant. Goodyear built mirror for Sundstrand Aviation, contractor for Air Force's ASTEC solar energy program.

Technical Countdown

ELECTRONICS

LFSW Guidance Still OK

Contrary to a report to MISSILES AND ROCKETS by a high Navy official in the Pentagon last week (M/R, June 8, p. 9), the Navy's new *Landing Force Support Weapon* guidance-system R&D program is still on schedule. Under development by the Norden Division of United Aircraft Corp. for the Bureau of Weapons, the missile guidance system is expected to meet Navy unit cost goals of $10,000 or less (nominal) in production, and, in fact, the first five prototypes are planned for delivery by mid-November. Three will be for flight test, open-loop, aboard *Sergeant* missiles at White Sands Missile Range, N.M., and two will be used for static tests. Also, both the Army and Air Force have reportedly requested briefings on the new system from Norden.

Process Advances SIC Production Art

A new process, developed and patented by Signetics Corp., obviates the reversed-bias P-N junctions normally used for semiconductor integrated-circuit isolation. First revealed in 1963, the process, said Signetics in a recent release of details, employs an isolation medium resulting from thermally grown silicon dioxide that extends around and about all components atop the monolithic substrate. Using the process, an experimental amplifier was built, the company said, having a gain-bandwidth product above 500 mc. Isolation-area leakage is reported at roughly 10^{-10} amps/cm^2; isolation breakdown voltage exceeds 1,000v.

Tory-IIC to Use Pneumatic Control

Electro-pneumatic linear-servo-actuator systems will be used in the upcoming *Tory II-C* nuclear-ramjet reactor full-power test within the next few weeks. Developed by the Bendix Corp's Research Laboratories Div. for reactor control, the subsystem is designed for high-temperature, high-radiation resistance. Built under an AEC contract, the actuators, claims Bendix, will function as required at a reactor inlet temperature of above 1,000°F. Although no actual figures were given, Bendix claims the system will withstand ". . . an extreme radiation environment without any massive shielding." Actuators include an electro-pneumatic servo valve, pneumatic motor transmission and electrical feedback transducer.

Hughes/U.K. Optics Firm Sign Agreement

The Hughes Aircraft Co.-developed laser rangefinder will be developed and produced in Europe under a recent licensing agreement reached with Barr & Stroud. To be built at the 75-year-old firm's Glasgow facility, the effort is expected to give the optical manufacturer a two-year lead in this field over other European competitors.

Laser/Peltier-effect Joined Successfully

First successful operation of an all-solid-state laser system (both laser and cooling mechanism) was announced recently by RCA's Camden Applied Research group. Employing Peltier-effect thermoelectric cooling techniques, the usual cumbersome cryogenic equipment required to handle and supply liquid nitrogen was eliminated. The semiconductor-laser output beam, said RCA scientists, was readily modulated by simple current modulation. A gallium-arsenide injection-diode laser and a three-stage cascaded cooler were employed. Laser pulse duration was 200 nanoseconds; measured laser threshold at —130°F was 40 amps.

SPACE RESEARCH

Double Probe Contract Set

A contract for a mother-daughter sounding rocket to probe ionospheric electron density has been placed by NASA Headquarters with Space Craft Inc., Huntsville, Ala. An *Argo D4* or a *Javelin* will loft a payload that will separate into two packages 32,000 ft. apart at an altitude of about 700 mi. Radio transmissions from one instrument package to the other and from both to ground will give information on electron density on International Data days. Secondary results of the experiment will be measurement of electron temperature and ion density. Transmission from one package to the other will take place at 612 mc. and 72 mc. One will transmit to the ground at 72 mc. The other will transmit to the ground at 240 mc. Test shots will be fired this summer.

MATERIALS

Steel Yarn Loom Operational at Goodyear

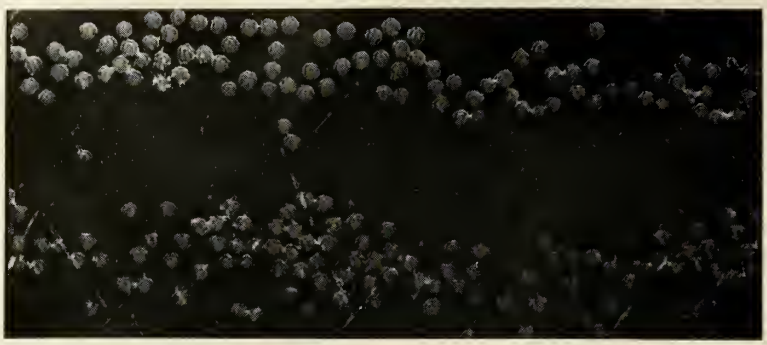
A 150-ton loom, capable of weaving 102,000 stainless steel strands simultaneously is turning out Airmat pneumatic structural material at Goodyear Aerospace Corp. Airmat is being pushed as a booster winged recovery system. Airmat is a three-dimensional fabric consisting of two layers of woven cloth connected by a series of drop yarns woven as integral parts of the two surface cloths. The new machine can weave Airmat of any length up to 8 ft. thick and 20 ft. wide. Operated by seven motors, it will complete from 1,000 to 1,500 sq. in. per hour. The machine is part of a $750,000 contract with tbe Manufacturing Technology Div. of the Air Force Materials Lab. Airmat is also being developed by Goodyear for helicopter rotor blades, expandable furniture and dual-wall vehicles for both underwater and space use.

Portable H_2 Fire Detector Perfected

A photon sensing tube that locates ultra-violet radiation from a hydrogen flame is used in a new portable hydrogen fire detector invented by Terry M. Trumble of the Aero-Propulsion Lab, a unit of the Research and Technology Div. of Air Force Systems Command. Hydrogen fires are invisible to the eye and small conflagrations may go undetected for time intervals long enough to initiate major fires. The photon sensor produces a signal in the operator's earphones when the hand gun is aimed at a hydrogen flame. Trumble expects to reduce the current 9-lb. weight of the unit to less than a pound.

SNAP 10 Reactor Goes Wet Critical

The compact nuclear reactor for the SNAP 10A space power system has achieved criticality with liquid metal coolant in the core at Atomics International's ground test facility near Los Angeles. A nuclear chain reaction took place with the coolant in the reactor and no significant heat was produced. The test is part of the series conducted by the North American Aviation division in developing the NaK system for space use in the 500-watt nuclear power package.



ONE-QUARTER-MIL glass filaments put into nickel by molecular forming of the matrix around the filaments. (General Technologies Corp.)

Air Force Admits Big Potential For Boron Filament Structures

by William Beller

WHEN GEN. Bernard A. Schriever said late last month that the greatest advance in the materials field "in three thousand years" was taking place and identified it as a plastic matrix of boron fibers, he sent a shock wave of security jitters up and down the Space Systems Div. of his own Air Force Systems Command as well as parts of industry (M/R, June 1, p. 17).

In Air Force eyes, everything connected with boron filaments, their manufacture, properties and use in composites has been classified, some of it retroactively.

A MISSILES AND ROCKETS query to the Aeronautical Systems Div. at Wright-Patterson AFB, Ohio, where the Air Force work on boron filaments is directed, brought the answer that there is no information or reports in the open literature.

This was surprising since two of ASD's engineers, F. Fechek and M. Hennessey, delivered a definitive paper, "Boron-Fiber-Reinforced Structural Composites," at an American Institute of Aeronautics and Astronautics conference last year. Reprints have been freely available to industry from the society and the Defense Documentation Center.

To complicate matters, both the Navy and NASA are sponsoring work on the use of boron in structures, and NASA's work, at least, is unclassified. In addition, some companies have worked on the problem on their own. Yet within the past few weeks, the Air Force has tried to put the damper on publication of any of these works "even when the material is simply of a handbook nature," one company maintains.

● **Lighter Minuteman**—Schriever's enthusiasm about the structural use of boron is seemingly warranted, especially in view of the remarkable stiffness of boron together with its low density. What this means, if the material lives up to its promise, is that structures such as rocket motor cases can be built big with a boron-fiber composite with lessened danger of their being overweight or destroyed by deflections.

The second-stage *Minuteman* case, for instance, could be made very much lighter and stiffer if boron filaments were used in its construction. This is borne out by calculations by Fechek and Hennessey. They showed in their AIAA paper that a design using boron filaments bonded into resin tapes as reinforcement in the longitudinal direction, and AF-994 glass filaments in the hoop direction, could be made 20% lighter and about 15% stiffer than the actual titanium case.

Specifically, the titanium case weighs 321 lbs. while the boron and AF-994 case is calculated at 258 lbs.; the respective flexural stiffness (EI) of the two cases is given as 5.15×10^{10}-lb. in.^{2} and 6.48×10^{10}-lb. in.^{2} The L/D of the case is 2.9 (127 in./44 in.).

Uses of boron composites include applications where high tensile strength, high resistance to buckling, low weight and high temperature resistance is needed. Some proposed uses are for the hull structure of deep-diving submarines—which reflects Navy interest—leading edges of high-speed aircraft wings and turbine blades.

● **Using metal matrices**—Where high load-bearing features are wanted, the material has been incorporated in metal matrices rather than plastic. The trick here is to get an intimate bond between the filaments and the matrix, particularly when the matrix material has a high melting point, and to have the filaments oriented to effectively carry the load. One company M/R spoke to claims to have solved this problem.

The physical properties that make boron attractive as a construction material are its relatively low density, 0.085 lb./in.^{3} (15% lighter than aluminum); extreme hardness, greater than nine on the moh's scale; high melting point in certain crystallographic forms, 3,700°F; very high modulus of elasticity, 60×10^6 lb./in.^{2}; very high modulus to density ratio, 7.05×10^8 in.; remarkable tensile strength in filament form, 500,000 lb./in.^{2}; and moderate resistance to oxidation.

Boron filaments are formed by vapor-depositing the material on a substrate, usually 0.4 to 0.5-mil titanium. Since the filament itself may run to 25 mils or larger in diameter, the substrate contributes little to the physical properties of the composite, which for design

purposes is treated as pure boron.

No material has been found that in the practical case can give a better modulus-density ratio than boron. Some companies are nevertheless looking ahead at compounds such as silicon carbide, theoretically with a higher ratio but not yet reached in the laboratory.

● **First it was burned**—Texaco Experiment, Inc., Richmond, Va., is probably the pioneer company in boron reinforced structures (M/R, Oct. 16, 1961, p. 14). Curiously, in 1950, the firm began studying boron as a high-energy additive to fuels, under an AF contract. Several years later, the Air Force dropped its work and the Navy took over. During the mid-1950's, the unusual physical properties of boron were discovered and the studies of the material took a turn to the structures area. Partially as a result of this work, boron composites were assigned a brilliant future in the Systems Command long-range study, Project Forecast.

Four years ago, the Air Force again contracted with Texaco Experiment to pursue further boron studies, but this time on composite structures. One result of this was an unclassified Texaco Experiment 166-page report, "Boron Reinforcements for Structural Composites," published in April, 1963, and upgraded to confidential in November.

The list of companies in the boron-filament and composite structures field includes General Electric, Lockheed and Aerojet-General, as well as several small companies.

General Technologies Corp., Alexandria, Va., is a very active company in the field. Admitting that they are working with boron filaments, as well as with other filament materials, the firm's officers pointed to the proprietary work they are doing on getting any filament into any matrix. Reluctant for competitive reasons to disclose how it is done, James C. Withers, vice president, claims that in many instances his company is able to form a 100% dense material of matrix and filaments in a process in which the highest temperature is that of boiling water.

This means that composites can be formed with matrices having higher melting points than the filaments, an obvious advantage where load-bearing and high-temperature strengths are needed. He describes the process as molecular forming. Withers says that he not only is able to get an integral bond but also is able to orient the filaments in any direction he wants.

Asked how quickly he could build up a structural shape of a composite, Withers said this depends on the matrix metal. With some, "we can form at the rate of about 0.001 in./minute; in other words, if somebody wanted a sheet of the material 0.03 inches thick, it is possible we could do the job in 30 minutes." He hastened to add that this is not true in all instances. "In some, it may take a whole day to get that thickness."

● **Cost the problem**—The biggest block to the use of boron filaments is to produce them economically. The filaments have been quoted at $4,000/lb. and up. Even so, one prominent manufacturer says that he doubts that anybody would take a fixed-price contract today even for the $4,000 figure.

The other obstacle is their economical incorporation in an oriented and integral manner into a matrix. Engineers feel that this last problem is much closer to solution than the former, although NASA and possibly the Air Force have some contracts out on ways to produce boron fibers in quantity.

One of the companies looking into the economical production of boron filaments is Astro Research Corp., Santa Barbara, Calif. Working under a NASA contract, Astro is trying to get boron to act like glass, and consequently, is trying to form boron filaments in a manner similar to the formation of glass filaments. This is only one of several avenues the company is exploring, H. Schuerch, its president, told M/R.

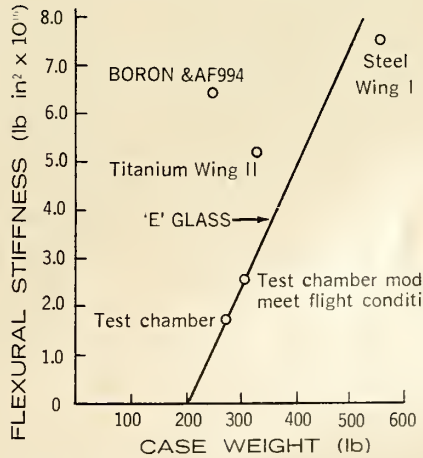
The firm is also looking at leaching processes. Here a filament of a boron-containing compound is formed and all except the boron is removed by a chemical process.

Looking ahead, some materials men see a mixture of filaments in a matrix to tailor-make composites for specific application. Boron, for example, has excellent tensile properties, but fails easily in shear and may have weaknesses in bond failure, plastic flow, creep or a combination of these. The answer, it is said, is to distribute the filaments in accordance with their strengths, using boron where it is needed and glass, perhaps, if it shows up better.

A less optimstic note on the subject of boron composites was struck by the vice president of one of the large missile/space companies. Maintaining that the process by its nature will never be amenable to economic production into useful structures, he claims that today's hue and cry about filaments is a ploy by high Air Force officials to get more research and development money. As far as M/R could determine, this is not the majority opinion. ■

Modulus-Density Ratios Compared

Material	Density (lbs./in.^{3})	Young's Modulus (lbs./in.^{2}) x 10^6	Modulus/ Density (10^8 in.)	Melting Point (°F)
B_4C	0.091	65	7.15	4,442
B	0.085	60	7.05	3,704
Be	0.067	40	6.00	2,328
Be_2C	0.088	45.6	5.19	3,902
SiC	0.116	68	5.86	3,812
TiB_2	0.160	77	4.80	5,288
BeO	0.109	45	4.13	4,622
Al_2O_3	0.143	55	3.84	3,659
TiC	0.153	45	2.94	5,652
E-glass (virgin)	0.917	10.5	1.05	—



EFFECT OF flexural stiffness on weight of rocket motor cases for Minuteman second stage.

GD/A's SATAR Will Serve As Space Probe, Re-entry Vehicle or Satellite

Due for first flight late this year, spacecraft has own propulsion system; details of this and earlier pod programs

by Willard E. Wilks

SAN DIEGO, CALIF.—General Dynamics/Astronautics will add a new vehicle to its stable of side-mounted hitchhiking space pods with first flight late this year of its *Satellite for Aerospace Research (SATAR).*

Currently in the R&D stage, *SATAR* is equipped with its own propulsion system to put it in orbit following separation from its booster. It will be capable of three basic missions—functioning as a high-speed re-entry vehicle, a 4,700-n. mi. space probe, or a scientific satellite.

The division has a contract for seven of the *SATAR* vehicles with the Air Force Office of Aerospace Research (OAR). Funding for the seven spacecraft, including their propulsion systems, totals $6.2 million.

All of GD/A's series of four scientific pods—including standard (non-recoverable) recoverable, infrared probe, and *SATAR*—have been designed to transport experiments economically into space attached to Air Force *Atlas* or *Titan* ICBM's which are assigned to other missions but have extra payload capacity.

To date, a total of 44 pods of all types except *SATAR* have been flown for OAR and the Defense Dept.'s Advanced Research Projects Agency and Defense Atomic Support Agency.

Of this number, 19 were the standard pod, 23 were recoverable, and two were infrared probes. Of the 19 standard pods flown, 15 were launched from Atlantic Missile Range (AMR) aboard Air Force E and F series *Atlas* missiles, and four were launched from Pacific Missile Range (PMR) by series D *Atlas* boosters. Three of the vehicles carried two pods each.

● **SATAR statistics**—*SATAR* is 55 in. long, 27 in. in diameter, weighs 100 lbs. empty and can carry a 200-lb. payload. It has a 30-in.-long cylindrical center section with 9.6 cu. ft. of volume for payload. End sections are hemispherical domes of drop-hammered duraluminum and provide the substrate for the solar cells.

All of the spacecraft's support system, including telemetry, command, battery and data recording system, are enclosed under the end domes. Equipped with the cradle which attaches it to the side of a booster and shrouds to protect it during exit, the assembly is 12.5 ft. long.

SATAR is equipped with a solid-fuel, single-stage rocket that weighs less than 600 lbs. and provides a velocity increment on the order of 6,000 fps to the satellite following separation from the prime booster.

● **On its own**—Separation altitude of the satellite, like that of the other scientific pods, depends upon the trajectory of the ICBM; generally, it is on the order of 150 n. mi. and occurs immediately after sustainer engine cutoff.

Sequence of events following separation from the prime boost vehicle is as follows: *SATAR* attitude control is enabled (gyros having been uncaged just prior to separation) so that the spacecraft in its initial position in space is referenced from the attitude of the launch vehicle. After the satellite separates, it goes through pre-programmed roll and pitch maneuvers as it coasts to apogee, at which point it has been oriented to the local horizon. The propulsion module then fires to establish orbit and is separated from the *SATAR*.

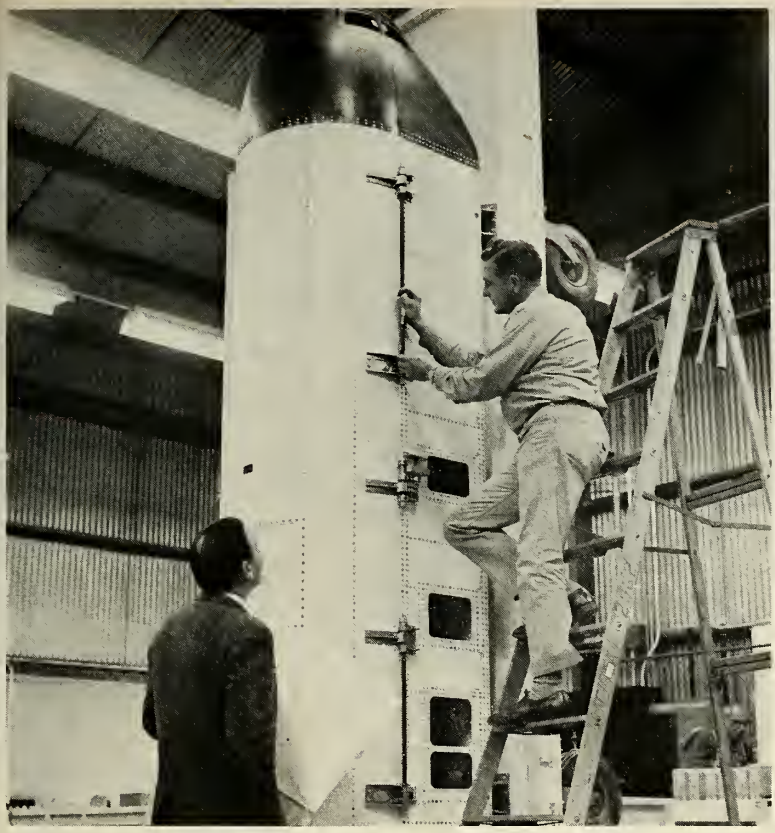
Configuration of the orbit is determined by the prime booster trajectory and the spacecraft weight, among other things. For nominal ICBM test launches from AMR, *SATAR* could be established in a near-circular orbit of about 500-n. mi. altitude at a weight of 300 lbs., while a spacecraft weight of 150 lbs. would permit establishment of a highly elliptical orbit with apogee altitude of more than 2,000 n. mi. *SATAR* could be launched from PMR into retrograde or polar orbit if desired.

There is no thrust termination in the *SATAR* rocket motor. It imparts a fixed amount of total impulse. The satellite's velocity vector is controlled by ballast. If, for example, *SATAR* was carrying a light payload and it was desired to reduce the velocity vector in order to establish a near-circular orbit, ballast would be added to the spacecraft.

Unlike *SATAR*, GD/A's other scientific pods assume a ballastic path similar to that of the prime booster, although one is equipped to fire two rocket probes.

SATAR also can be programmed as a high-altitude probe. For high-velocity re-entry research, it can fire its propulsion module on the downward leg of its trajectory to reach re-entry speeds of 30,000 fps for a 100-lb. payload.

● **Tried and solid**—Wherever possible on *SATAR*, GD/A utilized developed and proven hardware, buying the components from other manufacturers and adapting them to the design. This includes the motor and the attitude-control system. The only real exception to this is the guidance system, which the division has had under in-house development for some time for an earlier pro-



FIRST SATAR satellite will be nestled in this "cradle" attached to the side of its Atlas launch vehicle. Cradle will protect the SATAR and its scientific payload from air friction as the booster blasts its way up through the atmosphere. Once in space, the cradle door will open and the SATAR will be ejected.

gram. Everything in the satellite is solid-state with the exception of two mechanical commutators and the mechanical four-channel tape data recording system.

The satellite is designed for at least 90-day lifetime and to be completely independent of the prime boost vehicle. The only interface with the booster is its mechanical attachment.

Design aim was to devise a system that could incorporate many experiments without making any significant changes in the structure or support subsystems. Intent was to provide the Air Force with the ability to support the scientific community with a vehicle that could conduct experiments at minimum cost.

● **Guidance & control**—The *SATAR* guidance and attitude-control systems are part of the propulsion module subassembly and are separated along with the propulsion unit after providing stabilization during the coast and burn phases of flight following separation from the booster. In orbit, *SATAR*, as currently configured, is an unstabilized satellite that will have a low random tumble rate of less than 2 rpm. If a stable *SATAR* is required in the future, GD/A can add a developed passive stabilization system to prevent tumbling of the spacecraft.

SATAR's "strapped-down" guidance and control system consists of an inertial unit containing the gyro package, a flight control electronics unit, and a magnetic core programmer, having no stable table for reference. The rebalance and logic circuitry is of welded module form employing a cordwood modular construction technique. Use of magnetic circuitry with static switching in the programmer contributes to high reliability. The programmer memory allows function continuance after power drop-out.

The guidance system uses three orthogonally mounted, floated, rate-integrating gyros operating in a pulse-rebalance mode. In addition to providing displacement information, this arrangement yields turning rate data without the use of rate gyros. The digital form of this information permits use of simplified motor-firing control logic. The packaging concept—welded modules mounted on a single plane with hard-wire connections—contributes to minimum weight and size, and maximum reliability.

The entire assembly is encapsulated with foamed plastic to provide structural rigidity and electrical protection for the circuitry. The system is low in weight—25 lbs.—and employs state-of-the-art techniques throughout. It is available for any vehicle requiring control of injection profile and attitude stabilization during coast and powered phases.

SATAR's attitude control provides the reaction forces necessary for three-axis attitude stabilization and programmed attitude orientation. It is a helium-pressurized hydrogen-peroxide system manufactured as a subassembly for attachment to an aft mount ring. It is assembled at Astronautics, fired in the test cell, packaged, and sent to the launch site.

After assembly at the launch site, the hydrogen-peroxide motor solenoid plugs are engaged and the propellant tanks filled. The hydrogen-peroxide tanks are filled at atmospheric pressure and remain unpressurized except by gas evolution until the helium leak squib valve is opened when *SATAR* is ejected from the ICBM. The peroxide and helium pressures are monitored during countdown to insure that the systems are GO.

During flight the helium temperature, peroxide and helium pressures, and acceleration data are telemetered to document system performance.

● **Something old**—The low-cost system was developed with high inherent reliability through the use of qualified, flight-proven components interconnected with a welded manifold integrally mounted on the system's own structure.

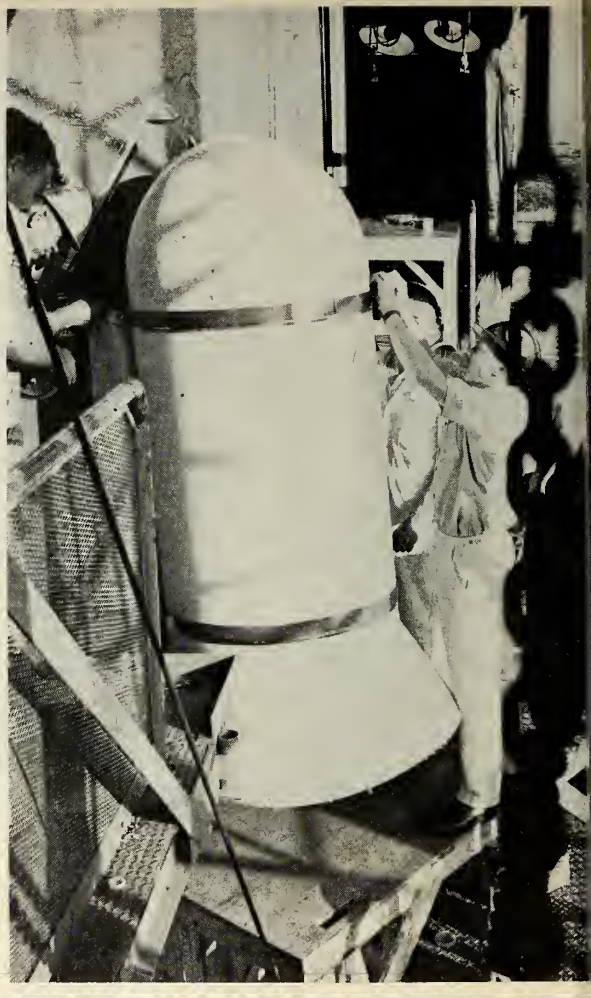
The hydrogen peroxide motors, qualified for the *ASSET* program, have flown on *Scout;* the helium regulator is qualified for and has flown on *Centaur*. The hydrogen-peroxide tanks are identical to those used for the *Scout* third stage. Qualification tests have been completed in previous programs while system vibration and duty-cycle tests have been performed to insure satisfactory lifetime performance.

● **Vertistat**—If there were a requirement for stabilization of *SATAR* in orbit it would use Vertistat, a passive, gravity-gradient, attitude-control system developed by Astronautics for satellite application. The device consists of a single extended primary rod and a pair of orthogonal extended secondary rods. The primary rod interacts with the gradient of the Earth's gravitational field to erect the satellite to the local vertical; the unequal secondary rods provide orientation about the local vertical.

Each secondary rod is coupled to the satellite by a torsion pivot in viscous joint. Relative motion of the secondary



STANDARD GD/A scientific pod is hoisted into gantry at Cape Kennedy for installation on side of Air Force Atlas. Each pod can carry more than one experiment, and many more than one pod can ride on the same booster.



RECOVERABLE POD is attached to another Atlas at the Cape. It is shorter than standard pods and has a flared aft end in which parachutes are housed to slow its descent on re-entering the Earth's atmosphere during experiments.

rods with respect to the primary absorbs energy and damps oscillation of the satellite. Parametric studies indicate that rod inertias, spring and damper constants can be selected to produce a system which will reduce attitude errors to one-third of their initial values in each one-half orbit.

● **Pods well used**—GD/A reports no lack of future payloads for its pods from companies and institutions who cannot justify the expense of the booster that would be required for even a small experiment.

Typical standard pod experiments to date have included a zero-gravity test launched from AMR Sept. 19, 1962, for NASA's Lewis Research Center. The experiment was made to measure liquid hydrogen heat transfer rates. The pod was instrumented to obtain temperatures, pressures, vacuum conditions, and liquid level of the high-energy liquid hydrogen *Centaur* fuel during extended weightlessness.

First pod of the series was launched by an *Atlas* at AMR on Oct. 2, 1961. It was a standard pod carrying a *Centaur* guidance system for vital tests prior to *Centaur's* first launch.

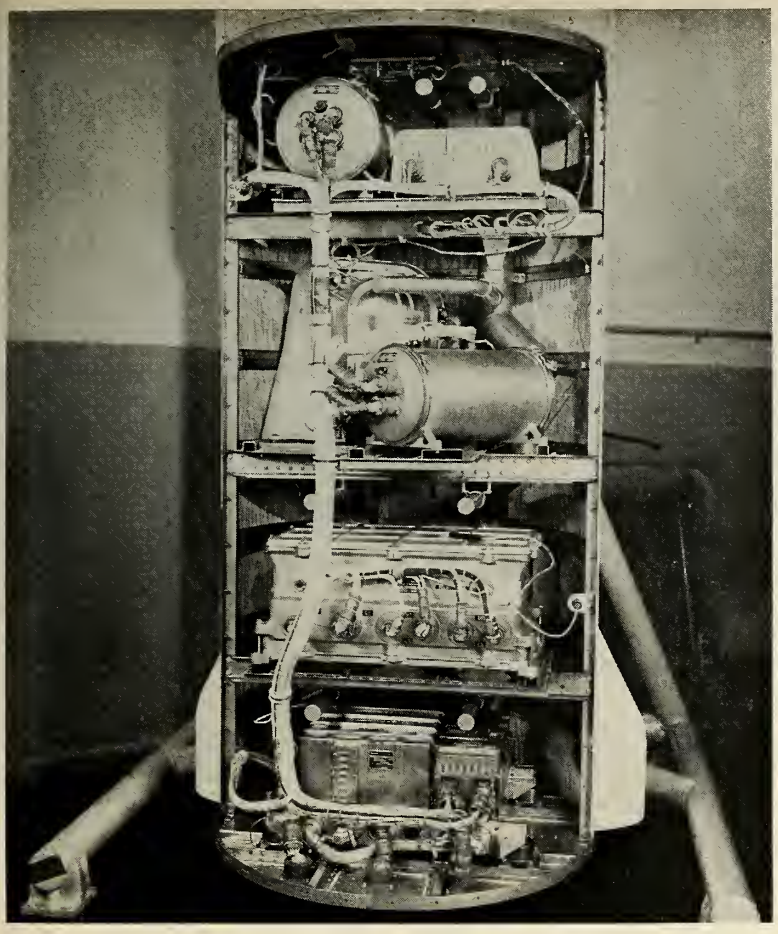
A standard pod has carried nine experiments, including missile plume radiometry, infrared radiometry, electrical structure measurement, and micrometeorite detection.

Experiments have been conducted for Air Force Special Weapons Center, Air Force Cambridge Research Labaratories, Utah State University, University of Utah, and the Martin Co. They include penetration aids and life support research.

● **Standard**—The standard pod is 8.5 ft. long, 30 in. in diameter, weighs 250 lbs., and can carry 350 lbs. of scientific experiments into space. The pod has a nose section of fiberglass laminate construction. Pod support systems consisting of power supply, programmer and telemetry are mounted in this area. The aft cylindrical section is a typical dural airframe structure and provides payload volume. The ejection system is a pneumatic-actuated device that provides a separation force upon command from the programmer.

Other specifications of the standard pod include: payload volume, 22 cu. ft.; power, capacity of 420 watt-hrs. per battery; peak, 1,680 watts; voltage, 28 plus 3 volts up to 15 amps.; telemetry system, PAM/FM/FM; trajectory, ballistic up to 1,200-n. mi. altitude.

● **Recoverable**—The recoverable pod, which has conducted re-entry experiments, is similar to the standard pod



FIRST SCIENTIFIC POD ever flown carried a guidance system for NASA's hydrogen-fueled Centaur space vehicle prior to Centaur's first launch. Pod contains guidance system signal conditioner and inverter (top shelf), inertial platform and electronics (second shelf), pulse rebalance electronics and power supply (third shelf), and navigational computer (bottom shelf). Launch occurred Oct. 2, 1961.

except that it is about 6.5 ft. long, 30-46 in. in diameter, weighs 1,200 lbs., can carry a 150-lb. payload, has a hemispherical nose structure and an aft end that is flared to provide aerodynamic stability during re-entry. It uses a modified standard pod ejection system and has a parachute recovery system in its aft end. A drogue parachute is automatically deployed to slow it during re-entry, and a balloon parachute is triggered for landing.

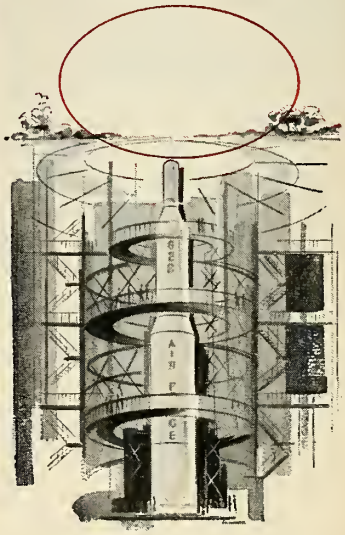
Some recoverable pods are equipped with radar beacons for tracking. An attitude stabilization system also has been provided. Maximum payload volume is 22 cu. ft.; capacity is 252 watt-hrs. per battery; peak, 1,000 watts; voltage, 28 plus 3 volts up to 9 amps.; telemetry system, PAM/FM/FM; channels, 18 IRIG channels per transmitter with commutation available; trajectory is up to 1,200 n.m. altitude.

● **Probe**—The infrared probe pod consists of a launch tube assembly, two probe assemblies, turntable assembly, and a ramp fairing. Launch tube assembly is 89.52 in. long and 29.52 in. wide. It consists of two rifled tubes which are capped to prevent aerodynamic heating of the probes. Caps are pushed off by the probes as they are fired.

The probe assembly is 57.7 in. long, 10.3 in. in diameter and weighs about 137 lbs. It carries a telemetry system, battery, telemeter antenna, programmer timer, three-channel radiometer, rapid scanning spectrometer, single-channel radiometer, magnet aspect sensor, and a small retrorocket.

The turntable assembly consists of a structural frame which supports the launch tube rotating assembly. Actuating force is provided by a pneumatic system which operates on command from the probe programer. The assembly rotates through 45 degrees. ■

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Philco Division Completes Reorientation

Western Development Labs' effort now concentrated in space systems, command & control, tracking; diversions avoided

by Robert Lindsey

PALO ALTO, CALIF.—Philco Corp.'s Western Development Laboratories (WDL) division here has completed a major reorientation of its goals and capabilities aimed at winning more business in the spacecraft research and development market.

Goal of the Ford Motor Co.-owned operation is to boost space system development to one-third of total sales, with the balance divided about evenly between command and control systems and ground tracking systems for spacecraft.

To expand into the market, the firm has invested several million dollars in new facilities for research, development and testing of hardware intended for the space environment, and new skills and technologies in system management and engineering have been added.

Until about two years ago, more than 90% of division sales came from work on the tracking and command system for the Air Force Space Systems Division's Satellite Control Facility.

Now it accounts for only 60%, reflecting first results of the diversification program. About 10% of sales are in space system design, with the balance in command and control system development.

● **Balance sought**—Oscar T. Simpson, Philco vice president and general manager of WDL, said new management goals aim for a roughly equal balance among these three areas. By specializing in the three areas—space systems, C&C tracking systems—Simpson emphasizes, the company is striving to avoid overdependence on any of the three.

For example, while it awaits a decision on whether the Defense Department will use its Medium Altitude Communication Satellite (MACS) design or contract for use of the Communication Satellite Corp. network, WDL is looking to several other potentially large programs to augment its leveling-off work as contractor for the USAF satellite tracking network.

Facilities expansion to date has been concentrated on equipping environmental and quality control testing laboratories for research on and qualifying satellite components and systems. Personnel skills have been bolstered in space technologies, space systems engineering and systems management.

Philco WDL's story is of a one-product company that saw a need for a broader business base, adopted a long-range plan exploiting its capabilities and then stuck with it, despite attractive diversions.



OSCAR T. SIMPSON, Philco vice president and general manager of WDL.

While WDL management concedes increasing competitiveness in the aerospace industry is creating a tougher market in which to make profits, it believes firmly in the soundness of its approach of meshing interrelated specialities of electronics, communications and space systems, Simpson said.

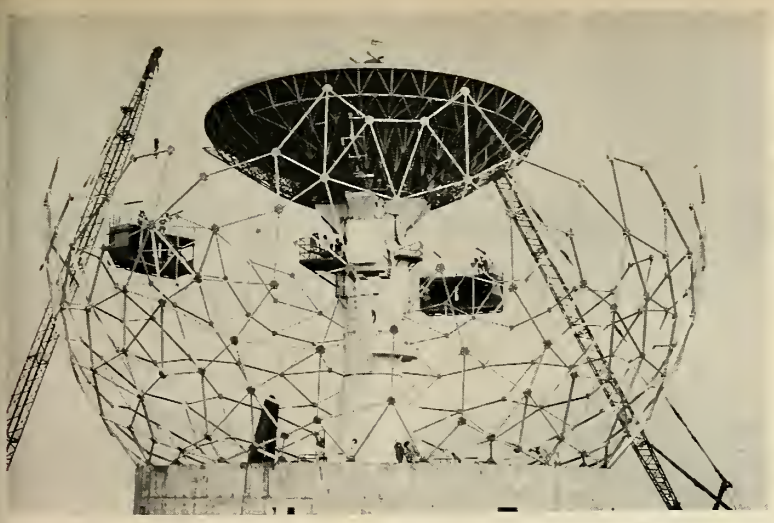
● **Divison's history**—WDL was established here in 1957 to develop and manufacture ground support and tracking facilities for the Air Force's WS117L program, which included *Discoverer, MIDAS* and *SAMOS.*

This program called for establishment of an advanced global network of wideband, sensitive tracking stations to serve as the command link with operating Air Force satellites and to receive data from the vehicles.

Details of the network have been suppressed as part of DOD's blackout on the military space program. However, it is known the stations have been located at Hawaii, Alaska, Vandenberg AFB, Calif., New Boston, N.H., in the Republic of South Africa and on a small island in the Indian Ocean off the African coast. Other sites may also be in the network.

When Philco Corp. directors decided to establish the WDL division here for the WS117L program, Simpson recalls, plans called for diversification beyond the Air Force program into other aerospace efforts. But the launching of *Sputnik I* in 1957 and companion Soviet breakthroughs in ICBM technology caused a big speedup in the AF satellite program. A small team of advanced planners looked into potential new market areas, but WDL's resources were saturated by the fast-moving Air Force program. As a result, the long-range plan to diversify stalled.

The only significant shift, Simpson





LEFT: Work proceeds on 60-ft.-dia. AF dish at new Indian Ocean tracking station. RIGHT: Close-up of antenna at factory.

says, came when Philco won the Army Signal Corps' *Courier* program, and in 1960 launched the nation's first active-repeater communication satellite. Philco directors' decision to do the work at Palo Alto rather than at another location shored up a corporate decision to concentrate the firm's aerospace activities here.

But when the *Courier* program died, WDL continued to be dominated by the Air Force effort. The *Courier* program, however, left a legacy in a quiet company-funded research effort on communication satellites. The firm's partiality toward medium altitude, rather than synchronous satellites, evolved at this time.

Late in 1960, Philco directors gave a go-ahead to Simpson to diversify, to invest in new facilities and personnel. In 1962, following acquisition of Philco Corp. by Ford, the plans were endorsed as part of the on-going program.

● **Concentrating the effort**—At the time, consideration was given to the entire aerospace field, Simpson recalls. Although it was obvious considerable effort would go into closing the propulsion gap with Russia, Philco decided to stick with its long-range plan and specialty areas.

"We knew for a few years propulsion would be getting the money. But rather than chasing after everything, we decided to continue in space communications and electronics and do our homework. We noticed that some of the advanced satellites NASA was thinking about were, in fact, very complex electronic systems. After the propulsion cycle was over, we knew it would come back—so we waited."

To a large part, Simpson believes, the company's policies have been proven sound. WDL's winning of DOD's MACS design competition with Space Technology Laboratories is given as part of the evidence. Fate of this program is uncertain while Defense Secretary Robert McNamara negotiates with Comsat Corp.

Other programs won by WDL since the reorientation began are a competitive position on the advanced solar probe, significant subsystems for advanced *Mariner* applications and space probe instrumentation. The most significant new program was the $36-million effort to equip NASA's Integrated Mission Control Center (IMCC) at Houston.

"We see ourselves as specialists in electronics and space communication systems management," Simpson said. Manufacturing of components in-house will be limited to components not available as standard items.

● **Seeking satellite business**—Besides the intention to compete more for NASA satellite systems, Simpson said WDL will be in the running, more and more, for Air Force satellites.

Meanwhile, the firm will continue competing for satellite tracking and command and control systems. WDL recently was named a finalist, with Collins Radio Co., for the *Apollo* network unified S-band system, a program worth $5 million with potential follow-on of $13 million.

Simpson sees a growing market for NASA tracking ship systems and is vying to satisfy NASA's current requirement for three new tracking ships. In the field of command and control, Simpson says there will be a growing foreign market.

Philco WDL is active in preliminary design work applicable to the *Manned Orbiting Laboratory* (*MOL*), but like the rest of the industry is waiting for DOD to define the requirements. Simpson said WDL would participate in the program as subcontractor to a prime industrial airframe or aerospace firm, but it is not yet affiliated. In previous space station studies, it has joined forces with the Boeing Co.

A major part of WDL's product manufacturing has been in the area of large parabolic antennas. The firm built at least six 60-ft.-dia. antennas for tracking, telemetry and data recording as part of the Air Force network, 40-ft.-dia. versions for NASA programs and 85-ft.-dia. versions for use in radio astronomy.

● **Ford's assistance**—Asked about the impact of Ford Motor Co. on WDL, Simpson said the division has perhaps felt the least effect of any Philco unit. "It has given us much stronger total financial backing," Simpson said of the acquisition. Also, Ford management offers counsel on all major decisions and programs, and "We could draw on their capability for certain big programs in the event we needed rapid expansion."

Ford does not divulge sales figures for its divisions, so it is impossible to chart WDL's sales picture. However, Simpson said sales rose sharply between 1957 and 1963, but have leveled off in the past two years, generally because the Air Force program has passed its peak. Employment is now 2,000 here and 300 at Houston, down from a peak of 2,700 a year ago.

While Philco, in its new orientation, has staked out the narrowly defined areas of spacecraft development, C&C and tracking facilities, Simpson said "it is a self-imposed barrier we regard as the most efficient division of our resources. If we want to depart from it and there are good reasons for it, there is no iron-clad rule to prevent it." ■

NASA To Get 'Optimized' Integrated Life-Support System Early Next Year

FINAL NEGOTIATIONS are now being concluded for the engineering of subsystems for a completely integrated life-support system that NASA says will advance the state of the art in several aspects.

General Dynamics/Astronautics is contracting with some 10 subcontractors, who will deliver subsystem equipment for the long-duration "optimized" life support system GD has designed for NASA.

First preliminary manned tests of the four- to six-man system will be made in December. According to specifications laid down by the Office of Advanced Research and Technology's Biotechnology and Human Research group, the concept is that the system would provide life support for as long as a year, with resupply of certain items every 90 days.

by Heather M. David

• **Pacing items**—Items that must be resupplied—presumably by a ferry vehicle—are such personal expendables as food and toothpaste and some atmospheric gases. Extra oxygen and nitrogen would have to be supplied for cabin or airlock depressurizations connected with extra-vehicular experimentation and to replace leakage.

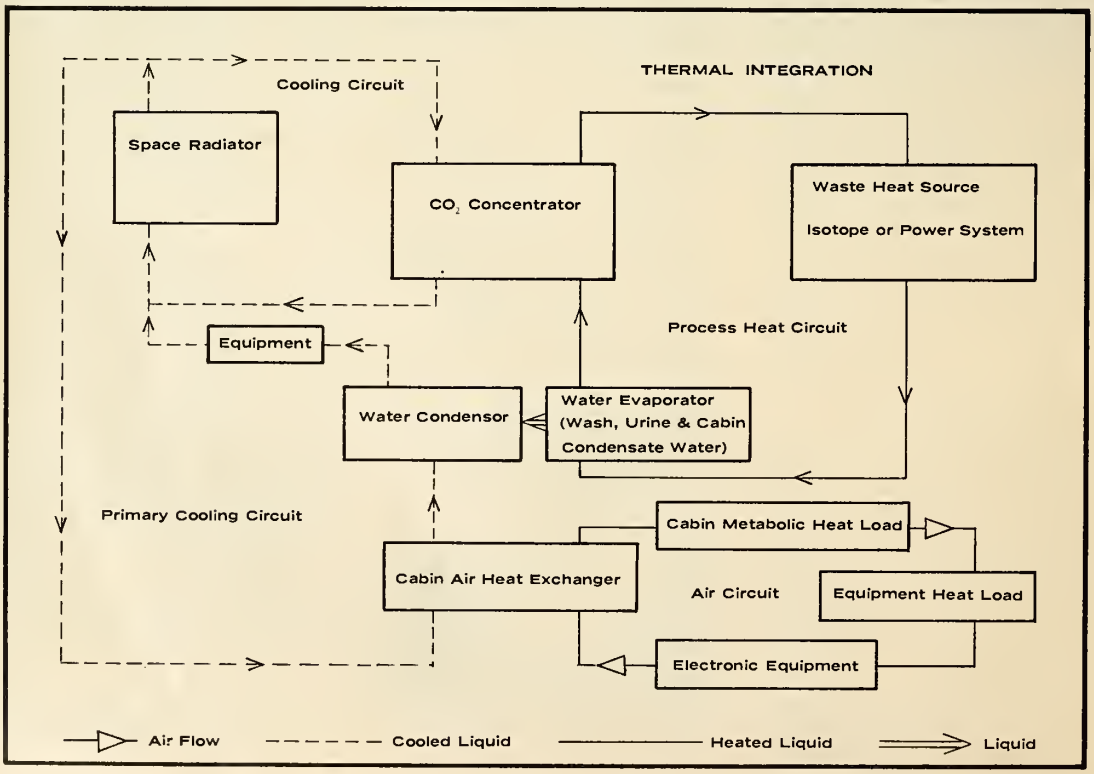
General Dynamics engineers estimate that food will comprise about half the resupply load each time. Freeze-dried foods required will weigh about 1.38 lb. per man each day.

All other subsystems will be regenerative. According to NASA's Layton Ingelfinger, concepts are employed that are far advanced over any others in use today.

General Dynamics is working on an 18-month contract, in which the first six months were spent in examining various concepts and doing complete systems analyses. The goal is to attain the optimum integrated system, with maximum reliability and safety and with minimum weight and power penalty.

The study differs from other concepts OART has supported, such as one presently nearing completion at the Boeing Co. (M/R, Jan. 27, p. 28), which tested advanced concepts as requested by NASA. The Boeing study, for instance, proved the feasibility of a biological waste processing unit, but such a unit is not necessarily considered best suited for spaceflight at this time.

• **Requirements**—General Dynamics will deliver an operating life-support system installed in a test bed to NASA by February, 1965. Although long-run manned tests are contemplated, no defi-



nite plans have been made. Such tests could take place at either General Dynamics, or at the Langley Spaceflight Center.

The system is to have flight prototype hardware, except for such items as the space radiator, which will be simulated.

The model chamber is 220 in. high and 215 in. in diameter, with a volume of 4,150 cu. ft. It also has an airlock containing 90 cu. ft. Maximum allowable leakage is 33.5 pounds per month.

The power source is radioisotopic, with maximum thermal power of 5 kw. Temperature is to be controlled to shirtsleeve environment. Atmosphere will be 10 psi oxygen-nitrogen, with partial pressure of oxygen 3.5 psi. It is assumed that each man will consume 1.87 lbs. of oxygen each day, and produce 2.32 lbs. of carbon dioxide.

● **Oxygen system**—Heart of the oxygen regeneration system is a Bosch reactor, said to have weight advantages over Sabatier reactors. The Bosch reactor also uses hydrogen to reduce carbon dioxide, but instead of producing methane—which must be dumped—the unit produces carbon and water in this reaction: $CO_2 + 2H_2 \rightarrow C + 2\,H_2O$.

Reaction temperature is from 800° to 1,200°F with an iron catalyst.

Carbon dioxide expired by the crew is collected by a molecular sieve (zeolite) after being passed over a bed of silica gel to remove moisture. The carbon dioxide is further purified in a CO_2 accumulator before being fed to the reactor. A catalytic burner is employed to dispose of trace contaminants, with activated charcoal used as a backup.

Ingelfinger said that in operational use the crew could also take along a Sabatier reactor with little extra weight penalty, in case the Bosch reactor should become unusable. Carbon removal has been the major problem in the Bosch equipment, because it tends to collect on the catalyst. NASA feels it has this problem solved, however. The third alternative, should both systems fail, is simply to dump CO_2 collected by the molecular sieve overboard, until one or the other system is repaired.

Water from the Bosch reactor is then broken down by electrolysis, with oxygen going back into the environmental control system and hydrogen back into the Bosch reactor. Ingelfinger said that the 40-lb. electrolysis unit, a double membrane cell, will operate at zero-g without rotating.

Nitrogen and oxygen will be stored at subcritical temperature. The company is not building a zero-g tankage system for these gases, but it will be about the only one that is not so engineered.

● **Water supply**—There are two separate units to process waste water.

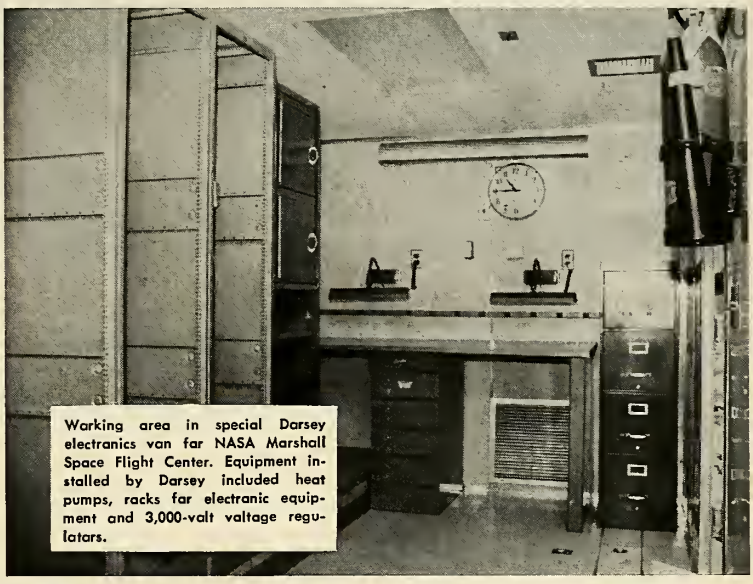
In one, urine is collected in a pretreatment tank, in which urea and bacteria are removed. The liquid then goes into an evaporator, then through a filter and water separator. Such water is then suitable for washing. Some water also is reclaimed from feces, the solid matter being stored antiseptically.

After use by the crew, wash water goes through much the same cycle, the end result being potable water. Water also can be recovered from humidity condensate, which is passed through activated carbon and bacteria filters. Ingelfinger said that this method alone probably would produce enough potable water for the four- to six-man crew for a number of days, should the other two units require repairs.

A new innovation in the system is the use of an isotope waste heat source, which will be used in the molecular sieve and urine recovery subsystems.

● **Heavy supplies**—General Dynamics has suggested that weight of equipment for personal hygiene will probably total about 30 lbs. for four men.

The study also encompasses space suit operation, and provision is made for emergency operation. ■



Working area in special Dorsey electranics van far NASA Marshall Space Flight Center. Equipment installed by Dorsey included heat pumps, racks far electranic equipment and 3,000-valt valtage regulatars.

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Apollo Pre-Modulation Processor Details Given

Demanding reliability requirements outlined at National Telemetering Conference; chief needs for Agena-Gemini rendezvous, interplanetary missions also discussed

LOS ANGELES—Television, biomedical data, voice communications, tape recorded data, vehicle telemetry, and emergency telegraphy in the *Apollo* manned spacecraft are all routed through one 14-lb. black box—the Pre-Modulation Processor—which has a predicted reliability of 0.999591 over a 336-hour lunar landing mission.

To improve chances of mission success, the PMP is packaged so that in-flight maintenance can be carried out. Should further studies show the need for higher reliability, spare modules will be carried. Required reliability at present is 0.9967.

The PMP also handles incoming communications from Earth, including voice and updating information for the guidance and computer equipment. It is a complex interface unit between the onboard radio transmitting and receiving equipment and the other spacecraft systems.

A description of the PMP and its reliability requirements was given at the 1964 National Telemetering Conference here, sponsored by the AIAA, IEEE, and ISA.

● **Reliability is demanding**—Design of the PMP from an electrical circuit point of view was not difficult, said R. D. Sturkie of North American Aviation. The problem was to meet stringent requirements of reliability, weight control, and power consumption.

A similar view was emphasized by other speakers at the conference, who described projects including telemetry for *Agena-Gemini* rendezvous and telemetry from a Mars lander to an orbiting *Voyager* spacecraft.

Designers who had to meet deadlines—as in *Agena* and *Apollo* vehicles—did not use microelectronics, in spite of the weight advantage offered. The *Agena* system uses printed circuit boards and welded stack modules. The *Apollo* system also uses conventional techniques. "At the time of the PMP design," said Sturkie, "a study showed that the use of microelectronics would be questionable in terms of reliability."

Describing signal conditioning equipment on *Apollo*—for monitoring electrical signals of spacecraft environment—I. J. Himmelberg and W. J. Barrier, NAA, said that reliability is obtained there by using simple circuits and components with a history of reliability.

Both the signal conditioning equipment and the PMP are being designed and developed by Collins Radio Co.

Astronaut telemetry—When they go outside the spacecraft, the astronauts will wear a portable life-support system that provides seven frequency-modulated telemetry channels for biomedical instrumentation. Transmission of this information will be time-shared between the three astronauts, via a VHF link to the Command Module and through the PMP.

In emergency conditions—failure of the unified S-Band equipment's power amplifier, loss of the high-gain antenna, or failure of the FM voice-modulator—the astronaut has an emergency telegraph key that can be used to modulate the S-Band transmitter with a 512-kc signal from the central timing equipment. This is the most reliable piece of communications equipment on board the spacecraft, having a reliability figure of 0.9999999 over 336 hours. Again, the emergency keyer operates through the PMP.

On all modes of operation of the PMP, except for emergency key, voice can be multiplexed with the data being transmitted. For transmitting analog data such as television, analog instrumentation, or biomedical data, playback is through the frequency modulator of the unified S-Band transmitter. This requires all analog data to be time shared on the FM-RF link.

● **Conserving power**—The switching of the PMP is designed so that modules not being used in any given mode of operation are taken off the power line. This keeps power consumption down to less than 10 watts.

In-flight replacement of malfunctioning modules has been incorporated in the pulse-code modulation telemetry system—one of the units served by the PMP. According to V. A. Durrel of NAA, redundancy techniques, if applied in system design, far outweigh the spares necessary for an astronaut to maintain the equipment for a typical lunar landing mission.

The PCM telemetry equipment performs self-checking functions to aid the astronaut in identifying a failure at the replaceable-module level. Radiation, Inc., is responsible for design and fabrication of this equipment.

The system is capable of sampling input data in accordance with two preselected formats: 51,200 bits/sec or 1,600 bits/sec. The first rate is used for most of the lunar landing mission. The slow rate is for the relatively inactive portions. It will also be used on the "blind" side of the Moon during the Moon-orbit phase of the mission.

For a period of about one hour, the spacecraft tape recorder records the 1,600 bits/sec signal at a slow tape speed. As the spacecraft comes back into view of the Earth, the recorded data are played back at 32 times record speed.

Apollo data storage—The data storage system on *Apollo* operates with both PCM telemetry and analog data sources. A total of 14 channels is recorded on a one-inch Mylar tape, five channels being digital data. Record and reproduce are possible in both directions of tape movement. Speeds available are 3.75, 15, and 120 inches per sec., although no data are recorded at the highest speed. It is used only for playback.

The tape transport for this system was developed by Leach Corp. and is semi-sealed to prevent adherence of magnetic oxide to the read-record heads under conditions of high temperature and humidity. A hermetic seal could not be used because the tape must be changeable. A bi-directional valve en-

sures pressure equalization, and accumulated moisture inside the valve is absorbed by a dessicant.

Agena-Gemini rendezvous—Real-time measurement of *Agena* vehicle velocity is mandatory before, during, and after *Gemini* mating procedures. To do this, a digital word representing the velocity to be gained during each engine-operating period is stored in a 16-bit counting register in the vehicle's telemetry system, by means of a command link.

As the engine burns, the increment of velocity gained is metered by a digital accelerometer and the counting register.

Following engine ignition, the preset contents of the register are counted down by pulses from the accelerometer until the register is emptied. Engine burning is automatically terminated and the vehicle "tail off" velocity is then measured by continuing the count.

● **How system functions**—Describing the system used, T. E. Linders and D. A. Ruskin of Lockheed Missiles & Space Co., said that the 16-bit velocity word is fed from the register into a telemeter buffer and thence into a 16-channel PCM multiplexer for periodic insertion into the telemetry PCM bitstream.

Into eight of the 16 blocks in the multiplexer are fed 64 two-level functions. Into the other eight blocks, from buffer registers, are fed a 16-bit vehicle time word (two blocks), a 16-bit velocity meter word (two blocks), and a 16-bit turbine velocity register output. The turbine velocity, used to measure engine performance, is sampled twice per second and so takes up four blocks.

Angular velocity of the engine turbine is one of several engine parameters used to measure engine performance. Turbine velocity is sensed by pulses produced in a magnetic pickup coil in the engine oxidizer pump housing.

When the amplitude of the transducer voltage is greater than a certain level, the telemeter will begin counting the pulses into a 20-bit totalizing register. The 16 most significant bits of this 20 bit word—directly proportional to the number of turbine revolutions—are then fed into the 16-channel PCM multiplexer for periodic interlacing. ■

electronics

System Simplifies Computer Use

by Rex Pay

SANTA MONICA, CALIF.—Conversational contact with a digital computer through office typewriters has been made available to the staff at Rand Corp. by the Johnniac Open Shop System (JOSS).

Ten minutes after connection to JOSS you learn to use your electric typewriter as a desk calculator; within an hour you can use it as a stored program computer. Finally, after about two weeks you learn to use it as a problem-solving aide with whom you can kick a mathematical problem around until you find out what you are trying to do. Then it helps you solve it.

Normally you cannot do this with a computer. You have to know exactly what you want to do, and how you aim to do it. You have to give the computer a program that tells in exhaustive detail how to solve your problem. And often the rules it plays by are so complex that a middleman, a programmer, has to convert your problem into something the computer can handle.

● **Efficiency not paramount**—Basically, the situation has come about because the aim has been to use computers as efficiently as possible.

JOSS throws overboard the idea of operating the computer at maximum efficiency. Intead, it confiscates a large part of the computer's capacity for use in easing communication between man and machine.

This is horrifying to many professional programmers, whose main aim in life is to squeeze the last ounce of computing capacity out of their machine. But it is based on sound economic considerations.

The trend in computers is for their size to increase, their difficulty in use to increase, and their cost per computation to decrease.

On a cost basis, more people can only use computers if a number of them can share one big machine. But this machine must be made much easier to use than it is at present. Fortunately, because cost per computation is coming down, it is becoming more economical to use part of the computing capacity of the machine to ease programming.

The result is a trend towards programming that is on-line (you feed in different parts of your problem as you go along) and time-shared (the computer divides its time between a number of users).

"In fact," says JOSS designer J. C. Shaw, Rand Corp., "I don't think we can afford more expensive computers *without* online time-shared programming."

When designing JOSS, Shaw's main aim was smoothness of interaction between man and machine. Choice of a normal electric typewriter is one example of this. Another is the use of two-color ribbon: black for computer output, green for the man's input.

Interactions between users and computers have been fairly stereotyped in the past and have been characterized by canned responses, as in stock quotations, inventory control, and some of the earlier forms of airline reservation systems.

In JOSS, the interaction is much more varied, with the computer not only pointing out errors in the problem formats given to it but also indicating the location of the error. If too many errors and subsequent corrections are made, the computer offers timely advice, typing out "It's a mess. Let's start over."

● **Widespread use is goal**—Of the eight typewriter stations in Rand, two are in the offices of individual users who have sole access to them. This is ultimately the way the system would be used. Another five are located in public areas, to be used by anybody, so as to get as wide a user reaction as possible.

"Enthusiasm for JOSS is unbounded" reports C. M. Baker who, being concerned with future computer systems within Rand, has followed the JOSS program closely. "The only complaint is that more JOSS is needed. People would like the system to be larger and faster and they want more stations. They would also like good documentation on the system. But it is very easy to experiment with. You cannot hurt the system. We encourage people to learn by experiment."

The computer that the JOSS is coupled to, Johnniac, is modest-sized by today's standards, and something of a maintenance problem. It has a 4,000-word (40 bits) core store and a 12,000-word drum.

● **Encourages computer novices**—Development of JOSS started about a year ago, with one day a week of Johnniac's time devoted to service of this project.

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building who have tried unsuccessfully to come into contact with computers before and have gotten hung up on the strange language and the artificial mechanisms. The same sort of system, however, could make a programmer much more efficient, greatly improving his knowledge of how to proceed in unsolved problems."

A professional programmer would find the present JOSS rather restrictive. With this type of system he cannot easily get double precision, complex numbers, large arguments, symbolic manipulation, text manipulation, or high-volume input or output. All these limitations were consciously let in, so that an example of a system that interacted extremely smoothly could be developed—to show what could be done.

Discussion with users shows that they would like to be able to save a program. At present, the computer will type out a complete program on demand. When the program is needed, it has to be typed in again. If the program could be recorded on punched paper tape or some other medium, the re-typing chore could be avoided.

• **Big potential**—To find out the potential demand for JOSS, a routine was added to the 7090 Fortran monitor at Rand so that it would print out statements on nature of jobs, amount of core storage used, time of execution, time of compilation, for each open shop Fortran job run through the large Rand system.

The results suggest that more than 50% of the present Fortran open shop jobs would be handled better in the JOSS interpretative routine rather than in Fortran, provided JOSS was equipped with the same processor as the Fortran system.

In the new system planned for the end of the year, the aim is to have roughly 2,000 JOSS words available to users. At ten characters per word this will amount to 20,000 characters, or 20 times the present capacity.

Hardware required for JOSS is a multi-typewriter control system and a special-purpose buffer between the typewriters and the computer. A communications unit is installed at each typewritter to couple the office machine into the system, over a two-way telephone connection.

• **Language is simple**—The language you use to talk to JOSS is pretty simple. About 12 verbs are used as commands, with a few variations. Error messages come out if JOSS cannot understand. Various functions are provided, such as sine, cosine, inverse trig functions, log to base 3, and a set of functions to handle integral and fractional parts of numbers.

The system works in the decimal mode throughout so that unexpected figures do not arise in binary-decimal conversions.

Once you have pressed the appropriate button and your typewriter is coupled into JOSS, you type your problem, put a period at the end of it and press the carriage return. JOSS will then type out the answer.

For example, if you type "Type $2 + 2$." and then press the carriage return key, JOSS would type "$2 + 2 =$ 4" underneath. More complex algebraic problems are set up by use of brackets and punctuation marks as a means of indicating the operations required. If you want the square root of x, where x is an integer between 1 and 10, you type "1.1 Type x, sqrt (x),—." on one line and then on the next line "Do part 1 for $x = 1(1)10$." A table of 10 square roots will then be typed out.

• **Sharing the system**—In the execute mode, JOSS allocates two seconds of computing time in turn to each of the eight users. However, a delay of this length does not appear in the user-computer interactions. Whenever interaction is required it is there, even though computing may be required by other users.

The system runs entirely interpretatively, each user's two-second time slot being equivalent to about 30 average interpretation cycles. At the end of each interpretative cycle, which is one statement within the machine, the supervisor unit will go and look at the input-output buffering system, to see if, during the last interaction cycle, anyone in the system has hit the carriage return. This is a signal to JOSS requesting processing of a line, and JOSS will respond and return to the computation cycle afterwards.

If six or seven people are trying to interact at the same time, there may be a delay of up to 1.5 seconds. In the execute mode, you may have anything between a Johnniac and one eighth of a Johnniac, and the response time can vary widely.

A typical example of a user's problem was that of an electronic engineer who wished to find out what a pulse looked like after it had passed through a filter.

The engineer knew the shape of the pulse in the time domain and the behavior of the filter in the frequency domain. He decided to carry out his analysis in the frequency domain and was faced with a complicated Fourier integral.

By tackling this problem with the aid of JOSS, the engineer was able to find out what the integrand looked like and could identify those errors resulting from numerical integration as opposed to those arising from truncation of the integral. ■

The Industry Week

Market Expert Sees Silver Lining

Robert W. Child, corporate director of marketing planning at Lockheed Aircraft Corp., believes the future of the Government aerospace-electronics market is not as black as the "gloomy headlines" indicate. He told the Western Electronics Manufacturers Assn. at a recent marketing symposium in Los Angeles he sees several areas in which an increase or continuation of a high level of aerospace-electronics spending can be expected. Improvements will continue in big missiles, including better penetration capability, more accurate guidance, and better command and control. The need exists to develop a defense capability against large ICBM's and submarine-launched missiles, possibly involving billions of dollars for defense systems and fallout shelters. There is a trend toward increased expenditures in the area of general-purpose aircraft, smaller missiles, ships, electronics equipment and special vehicles. R&D funding, though down slightly in 1965, is expected to remain large. Child also views NASA's operations as a major source of continued health for the industry.

Mergers and Acquisitions

Aerotest Laboratories, Inc., Deer Park, N.Y., has acquired from United Electro Dynamics, Inc., its United Testing Laboratories division. The acquisition, which became effective June 1, resulted in a change of Aerotest's name to United Aerotest Laboratories, Inc. The United Testing Laboratories will be operated as a wholly owned subsidiary. . . . *Raytheon Co., Lexington, Mass., has acquired Micro State Electronics, Murray Hill, N.J., producer of solid-state microwave components and microwave semiconductor devices. The acquisition was Raytheon's second purchase of an electronics firm within a month. The firm reached an agreement to acquire Penta Laboratories, Inc., of Santa Barbara, Calif., early in May.* . . . Parker-Hartford Corp., Windsor, Conn., has purchased Grandahl Tool & Machine Co., West Hartford, Conn. GT&M specializes in automatic production machining of precision metal parts for the electronics, aircraft, business machine and machine tool industries. The company's facilities have been moved to Windsor and will operate as the Grandahl Machine Div. of P-H. . . . *Thompson Ramo Woolridge, Inc., has initiated an acquisition program under the direction of TRW Electronics vice president, T. M. Fitzgerald. Goal is to acquire products, product lines, divisions or whole companies in the electronics field.* . . . Milton J. Shapp, president and board chairman of The Jerrold Corp., Philadelphia, with a group of associates has purchased 289,150 shares of Jerrold common stock from Carl M. Loeb, Rhoades & Co., New York investment firm. The purchase was the second major acquisition of Jerrold stock by Shapp since he returned to active management of the electronics firm 11 months ago.

New Activities

Avco Corp., New York City, has created a new research division in Tulsa, Okla., replacing the former Avco Spaceflight Programs Office there. The new division has contracts for research in spaceflight design studies, space vehicle instrumentation, biophysics, cryogenics and laboratory environment equipment. . . . *Dynamic Seals, Inc., has been formed in North Hollywood, Calif., to manufacture environmental type electrical connectors and hermetically sealed squib housings.*

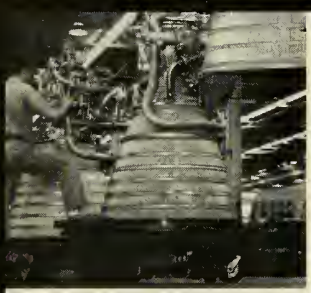
Industry Facilities

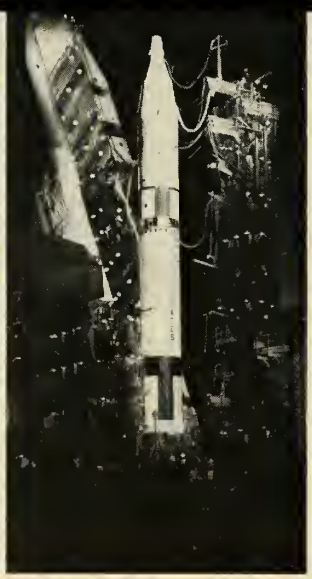
Air Reduction Co., New York City, has reported it is spending "several million dollars" to create a nation-wide distribution system for liquid helium, to be manufactured by a second, unidentified firm in the Midwest. AR's connection is to deliver a portion of the helium. The transportation system is scheduled to begin operation in the second quarter of 1965. . . . *Melpar, Inc., has announced plans to add 22,000 sq. ft. to its Northern Virginia complex. The new Environmental Test Laboratory, to be built in Springfield, Va., will house equipment to perform environmental tests on most defense, federal and standard test specifications. The complete facility is valued at just over $1 million.* . . . DATAtronix former Norristown, Pa., electronics manufacturer, has moved to a new 5,100-sq.-ft. facility in the Union Hill Industrial Park, West Conshohocken, Pa. The new plant is valued at $65,000, and will house some $100,000 in equipment. . . . *Hayes International Corp., has purchased a 25-acre site in the Huntsville, Ala., Research Park. Purchase is said to represent the first phase of a Hayes corporate plan for reorienting and centralizing its missile/space support activities in the Huntsville area.* . . . Industrial Nucleonics Corp., Columbus, Ohio, has dedicated a new 52,000-sq.-ft. building to house research and manufacturing activities. Industrial Nucleonics develops electronic on-line analytical instrumentation for process control. . . . *Vitro Corp. of America has moved its executive offices from 261 Madison Ave. to 90 Park Ave., New York City.* . . . Lockheed Missiles & Space Co. has under construction in Sunnyvale, Calif., a multi-million-dollar applied bioastronautics research facility. The 50,000-sq.-ft. facility is scheduled to become operational later this year.

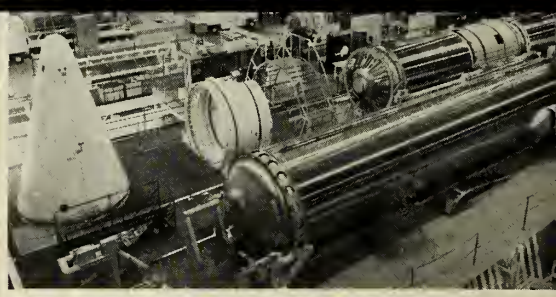
Company Representatives

The Piezoelectric Div., of Clevite Corp., has appointed Space-Tronics, Inc., Mineola, N.Y., northeastern district sales representative for its line of self-generating piezoelectric accelerometers. . . . *San Fernando Electric Manufacturing Co., San Fernando, Calif., has named Hathaway Electronics, Inc., Cambridge, Mass. to represent its West-Cap capacitors and filters and General Scientific precision potentiometers in the New England States.*

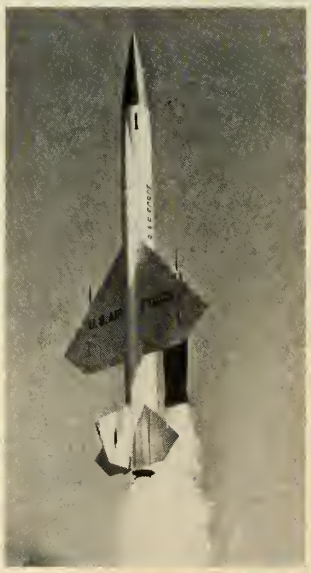
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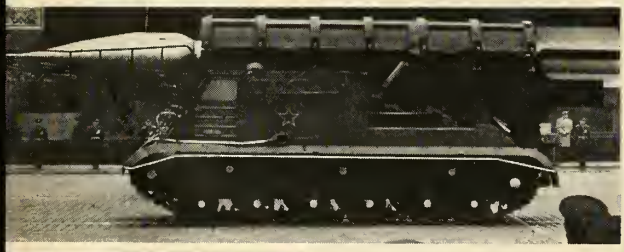






















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contracts

AIR FORCE

$46,400,000—**Thlokol Chemical Corp.,** Bristol, Pa., for follow-on production of stage one motors for *Minuteman* ICBM's.
$5,000,000—**General Electric Co.,** Philadelphia, for work on re-entry target vehicles for the *Nike-Zeus* system.
$3,700,000—**Adler Electronics, Inc.,** New Rochelle, N.Y., for a "build back" recovery communications system.
$3,000,000—**ITT Research Institute,** Technology Center, Chicago, for continued operation of an electromagnetic compatibility analysis center.
$1,000,000—**Northrop Corp., Nortronics Div.,** Palos Verdes, Calif., for development of a precision airborne photographic system for use in missile flight.
$599,986—**Sperry Rand Corp.,** Blue Bell, Pa., for memory systems for microcircuits.
$474,000—**Maxson Electronics Corp.,** Great River, N.Y., for production of fuses for the *Falcon* air-to-air missile.
$280,645—**Aerojet-General Corp.,** Sacramento, Calif., for space-optimized propellants.
$246,225—**Atlantic Research Corp.,** Alexandria, Va., for study of high-energy solid propellant efficiency.
$246,500—**General Motors, Inc., AC Spark Plug Div.,** Milwaukee, Wis., for spare parts for *Titan II* inertial guidance.

ARMY

$5,400,000—**Bendix Corp.,** Teterboro, N.J., for simulator stations for training personnel to use the *Nike-Hercules* missile system.
$640,415—**H. J. High Construction Co.,** Orlando, Fla., for construction of a security headquarters building and base operations building at the Merritt Island Launch Area.
$542,288—**Smith and Sapp Construction Co.,** Orlando, Fla., for construction of an ordnance field test laboratory and additions to other buildings.
$300,000—**General Precision, Inc.,** Link Group, Binghamton, N.Y., for a semi-automatic "V" angle reader.

NAVY

$2,800,000—**Chromcraft Corp.,** St. Louis, for work on *Mighty Mouse* rocket launchers.
$2,500,000—**General Electric Co.,** Pittsfield, Mass., for guided missile fire-control systems.
$1,100,000—**Melpar, Inc.,** Falls Church, Va., for work on a communication system.

NASA

$900,000—**Aerojet-General Corp.,** Sacramento, Calif., for solid rocket motors.
$500,000—**Alpha Microelectronics Co., Inc.,** Beltsville, Md., for vacuum deposition services for Goddard Space Flight Center.
$408,260—**FMC Corp.,** Indianapolis, Ind., for spray chamber circulation pumps.
$357,067—**Lear Siegler, Inc.,** Grand Rapids, Mich., for study of launch vehicle optimization.
$319,477—**Baird Atomic, Inc.,** Cambridge, Mass., for a starmapper assembly for Project Scanner.
$261,552—**Ampex Corp.,** Redwood City, Calif., for a recorder/reproducer system.
$143,372—**Booz-Allen Applied Research, Inc.,** Chicago, for study of procedures for assembly, checkout and launching of space vehicles.
$100,000—**University of Michigan,** Ann Arbor, Mich., for a one-year investigation of certain types of detonations to determine if they can occur in rocket engines and cause engine failure.
Walter Kidde & Co., Inc., Aerospace Div., Belleville, N.J., for development and production of the main propulsion system and auxiliary attitude-control motors for the Lunar Landing Vehicle Simulator at Langley Research Center (amount undisclosed).

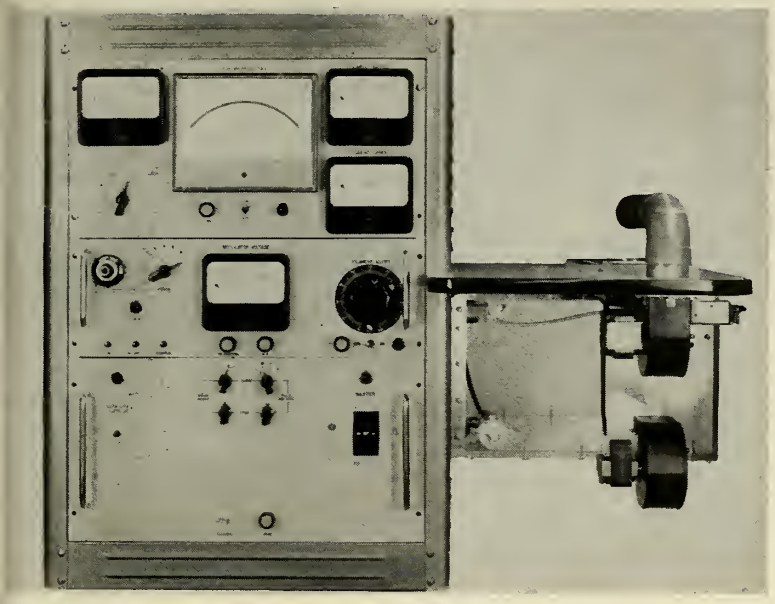
INDUSTRY

$1,850,000—**Micro Systems, Inc.,** Pasadena, Calif., from **North American Aviation, Inc.,** Space and Information Systems Div., Downey, Calif., two contracts to provide temperature and pressure transducer instrumentation for *Apollo* spacecraft.
$1,000,000—**FMC Corp., Ordnance Div.,** San Jose, Calif., from **The Boeing Co.,** Seattle, for assembly and test of a suspension and alignment system for use in the *Minuteman* ICBM program.
$690,000—**Westinghouse Electric Corp.,** Pittsburgh, from **The Boeing Co.,** Seattle, for a pilot line integrated circuit laboratory to be installed in the Boeing space center at Kent, Wash.
$340,000—**E. D. Jones Corp.,** Pittsfield, Mass., from **Cohu Electronics, Inc.,** Massa Div., Hingham, Mass., for castings and housings to be used as components in a sonar transducer for the ASW program.
$154,000—**Bethlehem Steel Co., Pacific Coast Div.,** Seattle, from **The Boeing Co.,** Seattle, for steel plates for use in modification of *Minuteman* silos.
$145,000—**Potter Instrument Co., Inc.,** Plainview, N.Y., from **International Computers & Tabulators, Ltd.,** London, England, for MT-120 digital magnetic tape transports for integration in the Atlas II computer.
$100,000—**Babcock Relays,** Costa Mesa, Calif., from **Philco Corp.,** WDL Div., Palo Alto, Calif., for mercury-wetted modules to be used in *Gemini* ground support equipment.

U.S. ARMS CONTROL AND DISARMAMENT AGENCY

$204,139—**Hudson Institute,** Harmon-on-Hudson, N.Y., for study of implications of possible future weapons technology on arms control and disarmament.

Circle No. 13 on Subscriber Service Card.



New Product of the Week: Pulse Modulator

E.F.E. Laboratories, Inc., is marketing a hard tube pulse modulator, providing negative pulses of up to 10-kv peak amplitude, 18 amperes peak current at 0.002 duty cycle.

The Model 211 has a pulse repetition rate adjustable from 200 cycles to 60 kc. Pulse width is adjustable from 0.08 to 7.0 microsecs; rise time is adjustable from 40 nanosecs to 0.3 microsecs. Power supply is adjustable from 0 to 11 kv and is regulated to within 1%.

Circle No. 151 on Subscriber Service Card

Seismic Survey System

The Geotechnical Corp. has developed a portable seismic survey system for measurement of the extent of Earth motion and its accompanying structural vibration.

The Model 18280 is a modular instrument package weighing 200 lbs. Ground and structural motions can be detected to levels as small as 10^{-6} g's acceleration; 10^{-8} meters, p-p displacement; 10^{-8} meters/sec., velocity; and 10^{-2} arc-seconds change-of-tilt. Recordings of seismic signals from 1 to 100 cps and tilt measurements are read directly with no analysis of recorded data required.

Circle No. 152 on Subscriber Service Card

Switch/Modulator

Somerset Radiation Laboratory, Inc., has developed the Model X406 switch/modulator/attenuator for use in systems with stringent weight and size requirements.

The device features a waveguide length of 0.5 in. and weighs less than 2 oz. Isolation bandwidth is more than 1,600 mcs centered at 9,000 mcs. Modulation is 75% from 8.2 to 9.8 gc and at least 52% from 9.8 to 12.4 gc.

Other specifications include a 250-watt peak power; 10-watt CW power; 1.25-db insertion loss (typical) at 9.3 gc and a switching time of less than 5 nanosecs from zero to full positive bias.

Circle No. 153 on Subscriber Service Card

Variable Bandpass Filters

Optics Technology, Inc., has developed a variable bandpass filter set for creation of light bandpasses of various widths in the visible spectrum.

The Model 60 consists of a combination of shortwave and longwave pass multilayer dielectric filters. The shortwave pass filters cut off in 50 millimicron increments from 400 to 700 millimicrons. The longwave pass filters cut in similar increments. Transmission for individual filters exceeds 80%.

Circle No. 154 on Subscriber Service Card

Absorption Wattmeter

A portable absorption wattmeter for accurate non-radiating termination and measurement of RF power in 50-ohm coaxial systems is available from Bird Electronic Corp.

The Model 6154 Termaline is designed for CW, AM, FM and TV modulation envelopes in the frequency range of 25 to 1,000 mc with maximum VSWR of 1.1. It reads RF watts directly without calibration adjustments or charts and has four power ranges—5/15/50/150 watts full scale.

Circle No. 155 on Subscriber Service Card

Signal Conditioning Units

A line of transducer bridge signal conditioning units is available from the Primary Precision Measurements Div. of Industrial Electronic Service Co.

Two models are presently available: Model SG-3, which rack mounts six units abreast, and Model SG-4, which mounts eight. Each plug-in unit is self-contained and consists of a power supply and bridge-conditioning portion for either four or six-wire systems. Capacity from the power line to output terminal is 0.05 pf.

Circle No. 156 on Subscriber Service Card

Test Systems

Component test systems are available from the Scionics Corp. for microcircuit and semiconductor aging, burn-in and testing.

Features include isolation between readout wiring and switching to eliminate power surges. The systems accept 2 to 12-lead components, including TO-50 and TO-80 flat packs and TO-3 through TO-12 header cans. The Model 720-3S simultaneously tests up to 200 three-lead components. All legs are switched simultaneously. Operating temperature range is −100° to 450°F.

Circle No. 157 on Subscriber Service Card

300-KC Counter

Systron-Donner Corp. has introduced a solid-state 300-kc counter, featuring remotely programmable count gate and stored in-line readout.

The Model 1011 has a frequency range of 2 cps to 300 kc. Sensitivity is 0.1v RMS; readout is four digit in-line stored. A variety of modifications include an internal crystal-controlled oscillator stable to one part in 10^5 per week; 5 mv RMS sensitivity amplifier and 1-2-4-8 binary-coded output.

Circle No. 158 on Subscriber Service Card

Power Monitor

Microwave Components and Systems Corp. is marketing a power monitor with a capability of 2.65 kw peak power over a temperature range of −10° to 75°C.

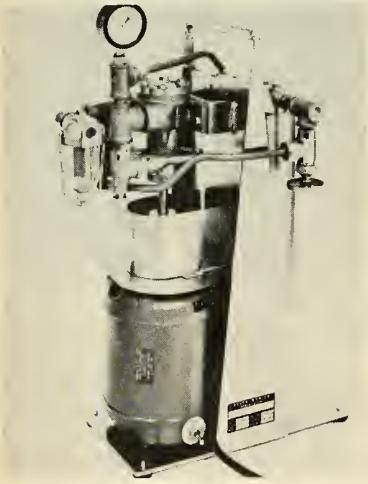
The Model X-330 can sample small quantities of power in the range from 8.2 to 12.4 gc. Energy from 45 to 85 db down from the main source is coupled to a detector by means of an adjustable probe. With the probe set for 45 db coupling, VSWR is less than 1.07 across the entire range.

Circle No. 159 on Subscriber Service Card

Recirculating System

A series of recirculating systems designed to continuously remove solid contaminants from the cleaning solution of ultrasonic tanks has been introduced by Delta Sonics, Inc.

The R-5 models have a flow rate



adjustable to 5 gpm, permitting the system to be used with a variety of tank volumes. The filter element is 50 sq. in. in area, eliminating frequent changes and down time. The unit is equipped with inlet strainer, pressure gauge, automatic by-pass relief system and grounded line cord.

Circle No. 160 on Subscriber Service Card

Digital Computer

A full-scale digital systems computer, featuring a flexible interface, complete input/output electronics and 1,024-word memory, is available from Pacific Data Systems, Inc.

The Model 1068 has both parallel and serial input/output capabilities and can operate independently or under varying degrees of operator control. Specifications include: word length, four decimal digits and sign, or multiples up to 24 decimal digits and sign; memory, magnetostrictive delay line operating at 2.02 megabits/sec.; input, three serial channels with a maximum input rate of 250 channels/sec., and parallel input channel; output, punch channel, 12 words/sec., parallel channel, 50 words/sec.

Circle No. 161 on Subscriber Service Card

Decommutation System

A solid-state telemetry decommutation system using modular construction and plug-in circuit boards is being produced by Stellarmetrics, Inc.

The Mark IV decommutation station is expandable to meet or exceed IRIG PAM/PDM requirements from 1 to 90 channels. A 900-channel system is available on order. The unit's phase-lock system will maintain synchronization over a 40%-commutation rate change, occurring at a rate of up to 5% and with as many as 15 consecutive missing pulses in the input signal. Continuous rate coverage is from one to 5,000 pps.

Circle No. 162 on Subscriber Service Card

Germanium Back Diodes

Micro State Electronics Corp. is marketing a line of germanium back diodes for use from UHF through X-band.

The Types 1040 through 1043 have a tangential sensitivity typically 6 db better than point contact diodes and burnout ratings improved by a factor of five to 10.

Circle No. 163 on Subscriber Service Card

Recorder-Reproducer

College Hill Industries, Inc., is marketing an inertia compensated continuous loop magnetic tape recorder/reproducer, the Model 005.

Designed to be immune to forces of acceleration (100 g's), vibration and shock, the tape transport operates in an inert fluid that matches the density of the tape. Specifications include: tape speeds—30, 15, 7½, 3¾ and 1⅞ ips; frequency response—flat from 300 cps to 100 kcs at 30 ips; wow and flutter—1% RMS maximum; delay time—one to 80 seconds at 30 ips; input power—28v dc at 0.7 amps maximum.

Circle No. 164 on Subscriber Service Card

Core-Welded Crystal

Reeves-Hoffman Div. of Dynamics Corp. of America is marketing a 1-mc semiprecision crystal that will maintain a stability of $\pm 1 \times 10^{-7}$ under 5 g's vibration in the 10 to 500-cps range.

Stability under aging is 5×10^{-9} after one week at 75°C. Temperature stability is 0.025°C; resistance is 8 ohms. The device has a leakage rate of 10^{-8} standard cu. cm. per second.

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Drop Calorimeter

A drop calorimeter incorporating a water bath and copper receiver capable of measuring solids, powders or liquids to 3,000°F in a vacuum or inert atmosphere and to 2,000°F in air is being manufactured by Dynatech Corp.

The Model SHDW-R30-4V measures the specific heat of samples from 25 to 100 grams. Accuracy of ±5% is obtained from room temperature to 300°F and ±3% from 300° to 3,000°F. The instrument uses a molybdenum-wound resistance heater for measurements in an inert atmosphere or vacuum of 1×10^{-4} to 10^{-5} mm Hg. Power requirement is 110v ac, 5.5 kw.

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Thermal-Vacuum Apparatus

Astronetic Research, Inc., is marketing the Model 2023 Space Environment Simulator, capable of pumping vacuums of 5×10^{-6} torr in five minutes. The thermal transfer plate cycles in five minutes from 100° to −50°C.

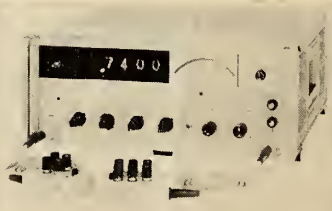
All controls are mounted on one slanted front panel. Coolant input and return lines are governed by a bayonet quick disconnect. In case of coolant loss, the unit switches off automatically.

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Calibrator Source

The Model 740A calibrator source, combining a dc standard source, a 0.01% differential voltmeter, a dc amplifier and a dc electronic voltmeter in a 7-in.-high package, is available from Hewlett-Packard Co.

The unit puts out continually adjustable voltages up to 1,000, indicated with six-place resolution on four nixie readout tubes and a taut-band meter. Output is accurate to 0.01% and stable within 0.003% per month. As a differential voltmeter, the unit provides an input impedance greater than 1,000 megohms. It compares voltages from 0



to 1,000v dc with an absolute accuracy of 0.01%.

As a dc power amplifier, the unit gives up to 60-db gain, with stability better than 0.001% and output up to 25 watts. As a voltage amplifier, gain is 120 db at isolated terminals.

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names in the news

James M. Wallace: Elected vice president of Westinghouse Electric Corp., Pittsburgh, Pa. Wallace is general manager of the corporation's East Pittsburgh divisions.

H. Burke Horton: Appointed director of research of Univac Div. of Sperry Rand Corp., New York City. **E. C. Thompson:** Named manager of the firm's Eastern Engineering and Manufacturing Operations.

Dr. Peter A. Cole: Named director of the Institute of Naval Studies, Franklin Institute's Center for Naval Analyses, Arlington, Va.

Lawrence J. Torn: Appointed vice president-new operations of Trygon, Inc., Roosevelt, N.Y.

Leo L. Helterline, Jr.: Elected vice president of the Benrus Watch Co., Inc., New York City. He will be responsible for marketing of the corporation's Technical Products Div.

Harvey L. Howell: Elected vice president-general manager of the Transducer Corp. and International Data Products, Inc., Puerto Rico subsidiaries of Potter Instrument Co., Inc., Plainview, N.Y.

Dr. Howard I. Oshry: Appointed director of research for Honeywell, Inc.'s Philadelphia Div.

Tracy C. Dickson III: Named manager of BLH Electronics, West, in Pasadena, Calif. BLH is a division of Baldwin-Lima-Hamilton Corp.

Walter L. Cain, Jr.: Appointed applications engineer for Whittaker Corp., Electronics Div., Los Angeles.

Daniel E. Cowgill, Judith A. Bancroft, Gilbert B. Rozran and **Jane-Ring Fritz Crane:** Appointed technical staff members of Research Analysis Corp., McLean, Va.

Dr. Carl H. von Kenschitzki: Named associate director of research-physical sciences for the Lockheed-Georgia Co., Atlanta, Ga. **M. David Prince:** Named associate director of research-systems sciences for the firm.

Edward J. Eggart: Elected president and treasurer of CompuDyne Corp., Hatboro, Pa. **Albert J. Feldman** was elected secretary.

Dr. Arthur Uhlir Jr.: Appointed manager of Semiconductor Div., Microwave Associates, Inc., Burlington, Mass. He was also elected vice president of the firm.

Arthur D. Jiannine: Joined National Transistor, Lawrence, Mass., as manager of materials development.

Leslie N. Albright: Appointed manufacturing manager of ACF Industries, Inc.'s Electroncis Div., Riverdale, Md.

Harold L. Alford: Appointed assistant quality control manager of Haveg Reinhold, Inc., Santa Fe Springs, Calif.

Aldon M. Asherman: Named manager of product planning for Sylvania Electric Products, Inc., New York City.

John E. McElligott: Appointed general manager of Leach Corp.'s Relay Div., Los Angeles.

Donald A. Myrick: Named director of administration at Phelps Dodge Electronic Products Corp., North Haven, Conn.

Hugh E. Beatty: Named manager of military systems department for the Ampex Corp.'s Computer Products Div., Culver City, Calif.

John W. Flanigan: Appointed field services manager of Telemetrics, Inc., Gardena, Calif.

Stanley R. Schoen: Appointed executive vice president of Lear Siegler Service, Santa Monica, Calif., a division of Lear Siegler, Inc.

Joseph M. Levon: Named chief engineer of Waterman Hydraulics Corp., Evanston, Ill.

Sterling Fisher: Named director of instrumentation engineering of Electronic Communications, Inc., St. Petersburg, Fla.

G. S. Curtis, Jr.: Appointed manager of reconnaissance and intelligence programs at Philco Corp, Aeronutronic Div., Newport Beach, Calif.

Weldon L. Brubaker: Appointed vice president and manager of the Florida Div., Electro-Tec Corp., Ormond Beach, Fla.

Preble Staver: Named Washington representative for Atlantic Research Corp., Alexandria, Va.

Joseph M. Stock: Appointed vice president-sales of Hillyer Corp., Mountainside, N.J.

Lyle Quatrochi: Named to head the Selenium Div., International Rectifier Corp., El Segundo, Calif.

Richard T. Petruzzelli: Appointed operations manager for the Electronics Div. of Fairchild Du Mont Laboratories, Clifton, N.J.

T. William Benedict: Promoted to director of marketing of the Singer Co.'s Metrics Div., Bridgeport, Conn.

Maurice Center: Appointed vice president and general manager of the Surface Equipment Div. of the Librascope Div. of General Precision, Inc., Glendale, Calif.

—when and where—

JUNE

20th Annual National Meeting of the Institute of Navigation, Barbizon Plaza Hotel, New York City, June 15-17.

Symposium on Molecular Structure and Spectroscopy, OSU, ONR, NSF, Ohio State Universtiy, Columbus, June 15-19.

Summer Scientific Seminar on Communication Cybernetics, Air Force Office of Scientific Research, Cloudcroft, N.M., June 15-26.

Special Summer Conference on the Scientific Mission and Engineering Design of an Orbiting Astronomical Observatory, New York University School of Engineering and Science, New York City, June 15-26.

International Conference on Precision Electromagnetic Measurements, IEEE and National Bureau of Standards, Boulder Laboratories, Boulder, Colo., June 16-18.

International Conference on Physics and Chemistry, Air Force Office of Scientific Research, Brown University, Providence, R.I., June 21-26.

Seminar on Microcircuit Equipment, Mesa Scientific Corp., Ambassador Hotel, Los Angeles, June 22-23.

67th Annual Meeting, American Society for Testing and Materials, Chicago, June 22-24.

International Conference on Photosensitization in Solids, Air Force Cambridge Research Laboratories, ONR, Space Physics Laboratory and Illinois Institute of Technology, Conrad Hilton Hotel, Chicago, June 22-24.

Seventh Molecular Beam Conference and Institute on Molecular Beams, Air Force Office of Scientific Research, Brookhaven National Laboratory and Uppsala University, Uppsala, Sweden, June 22-July 7.

Conference on Precision Electromagnetic Measurements, sponsored by the National Bureau of Standards, IEEE and International Scientific Radio Union, NBS Boulder Laboratories, Boulder, Colo., June 23-25.

11th Annual Symposium on Computers and Data Processing, University of Denver Research Institute, Elkhorn Lodge, Estes Park, Colo. June 24-25.

Fifth Joint Automatic Control Conference, IEEE, AICE, ASME and ISA, Stanford University, Stanford, Calif., June 24-26.

International Symposium, Fundamental Phenomena in Hypersonic Flow, Cornell Aeronautical Laboratory, Buffalo, N.Y., June 25-26.

1964 Conference on Aerospace Education, National Aerospace Education Council, Hotel Mayflower, Washington, D.C., June 25-27.

First Annual Meeting and Technical Display of the AIAA, Sheraton-Park Hotel, Washington, D.C., June 28-July 2.

Aerospace Reliability and Maintainability Conference, sponsored by the SAE, ASME and AIAA, Statler-Hilton Hotel, Washington, D.C., June 29-July 1.

First International Congress on Vacuum in Space Research, French Society of Vacuum Engineers and Technicians, Paris, France, June 29-July 3.

JULY

Annual Meeting of the National Society of Professional Engineers, Grove Park Inn, Asheville, N.C., July 1-4.

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Withdrawal from Reality

A NATIONAL DEBATE now under way in the political, scientific and technical community borders on insanity. Supposedly responsible, intelligent men are urging upon us a course which if followed would result in the destruction of the nation.

They advocate unilateral abandonment of the arms competition with the Soviet Union despite the lack of any agreement whatever with the Russians in this field, let alone any enforceable agreement. We are not talking about the fringe of nuts who want us to disarm. Our concern of the moment is with those who believe that our example in failing to press development or deployment of new weapons will induce the Russians to follow our lead.

We have seen nothing in the history or attitude of the Soviet Union to convince us it would be so inclined. There is no question at the moment of the overwhelming military superiority of the United States. There also is no guarantee that technological advancement cannot dissipate that superiority quickly or that the Russians cannot eliminate it by continued arms development and production. Nor is there any guarantee that the Soviet Union will be willing to accept permanently its position as an inferior power in the military field. Indeed, all logic would point to the opposite conclusion.

Much of the reasoning behind the foolhardy argument of unilateral nonarmament seems to rest on the fear that any further weapons development or deployment on our part would convince the Russians we are preparing to destroy them. Thus, it can be argued that we should not prepare sensibly against the possibility of war by instituting a fallout shelter program or deploying an anti-ballistic missile system. This, it is suggested, would alarm the Russians into escalating the arms race.

This is a paper tiger. The same argument was used against deployment of the soft-based *Atlas* missile—that our production of an exposed, aboveground ICBM would trigger a Russian conviction that we were planning a first strike and therefore perhaps lead them to an actual first strike. We have seen no evidence that the soft *Atlas* program had any particular effect on the continuing Russian suspicion of this nation's motives.

If the nuclear threat has reduced us to such a state of timidity that we dare not risk alarming the Soviet Union by building the weapons we require to defend ourselves, then perhaps we deserve to disappear in a blossoming mushroom cloud.

We have nothing against properly enforced arms reduction which is not unilateral. We have nothing against sensible unilateral reduction of the Dept. of Defense budget if it can be achieved while still meeting the nation's defense requirements.

But we disdain the school of thought which puts before us such arguments as these by Princeton professor Freeman J. Dyson in the current issue of the *Bulletin of the Atomic Scientists:*

"The crucial problem that remains is to convince the American Congress and public that Soviet ABM systems are not necessarily a deadly threat. The American people must become accustomed to the idea that they may be better off without an ABM system, even if the Soviet people believe they are better off with one. Perhaps this re-education of the American people cannot be achieved without some help from the Soviet government. For example, some unmistakeable evidence of restraint in Soviet ABM procurement would help a great deal. With or without such help, we must do the best we can."

We won't bore you with the reasoning by which the professor reaches this conclusion, but we do want to point out his explanation that security on the two sides is different: "On our side, security is adequately protected if the analytical computations of thermonuclear exchanges indicate that enough of our second-strike force will certainly penetrate the Soviet defenses. On their side, security is adequately protected if the Soviet armed forces have the finest weapons that anybody knows how to build, irrespective of paper calculations."

This is from a man who has been a consultant to the Dept. of Defense.

PERHAPS EVEN MORE DANGEROUS in this debate is the position taken by columnist Stewart Alsop in a recent issue of the widely read *Saturday Evening Post.* Mr. Alsop tells us that the revolution in weaponry is now about complete. Everything, it seems, has been invented.

"The evidence supporting these conclusions is simple," he reports. "In recent years, both the United States and the Soviet Union have spent colossal sums of money on research and development of weapons. But during those years, the scientists have been unable to come up with new, genuinely revolutionary weapons to compare with the atomic bomb, the hydrogen bomb and the intercontinental ballistic missile."

This, Mr. Alsop tells us, is good news. We should be relieved that the revolutionary phase in weapons development is over and that no further big technological advances are in the cards.

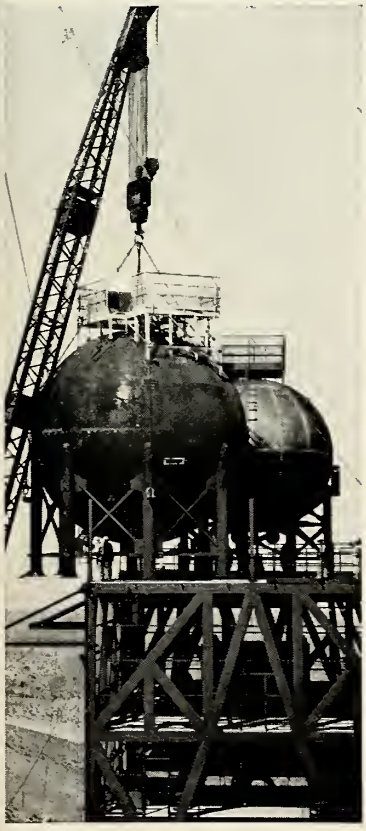
"It is good to know that the balance is unlikely to be upset by some sudden revolutionary technological breakthrough of the sort that lit up the skies over Hiroshima almost two decades ago," he concludes.

Peddling of this unrealistic theory to the American people by such a usually astute columnist makes us wonder if there is not some mentally debilitating Russian germ loose in the land.

Continued seeking for the great technological advances and possession of the finest weapons anyone can build is the nation's only real security. To follow the reasoning of Mr. Alsop and the professor and their ilk is to court national disaster.

William J. Coughlin

USS 304 STAINLESS STEEL USED FOR 450-TON-CAPACITY LOX TANKS AT F-1 TEST STAND



This is the first of three new stands for static testing of the F-1 engine. Rocketdyne, a division of North American Aviation, Inc., operates the stands for NASA's Marshall Space Flight Center. Ralph M. Parsons, architects and engineers, wrote the purchase specifications; Standard Steel Corp. and American Bridge, Division of U. S. Steel, formed a joint venture for the design fabrication, and erection of the spheres and test stands.

Perched atop a huge static test stand at Edwards Air Force Base, these two 90,000-gallon tanks feed liquid oxygen to test the F-1 engine built by Rocketdyne, a division of North American Aviation, Inc., under the technical direction of NASA's Marshall Space Flight Center. Five F-1s will provide 7,500,000 lbs. of thrust for Saturn V's first stage booster. Each sphere is a double-walled unit. A carbon steel outer skin encases 18 inches of insulation. Inside, a 28½-ft.-diameter sphere made of USS 18-8S Type 304 Stainless Steel stores the liquid oxygen at—297°F.

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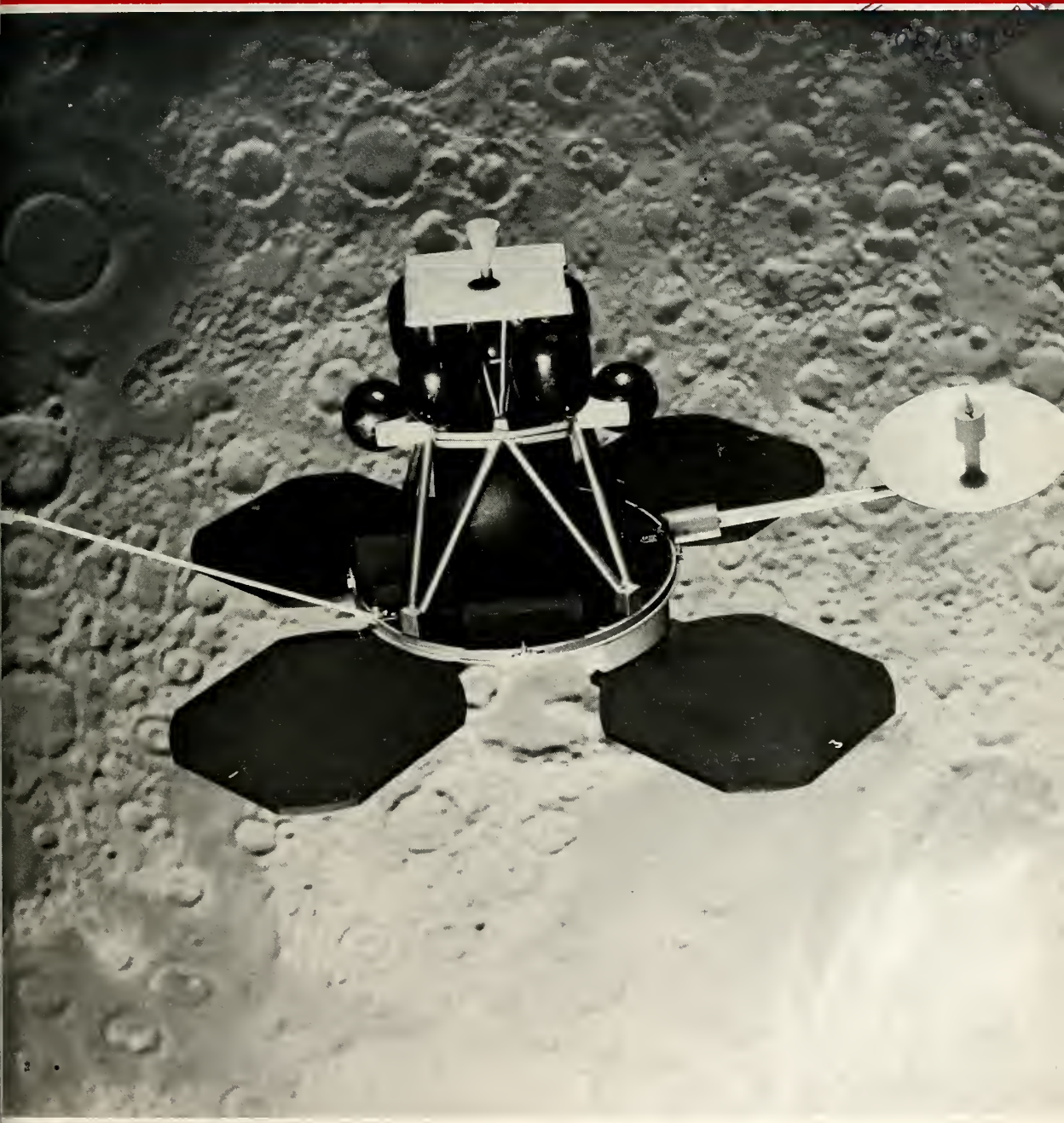
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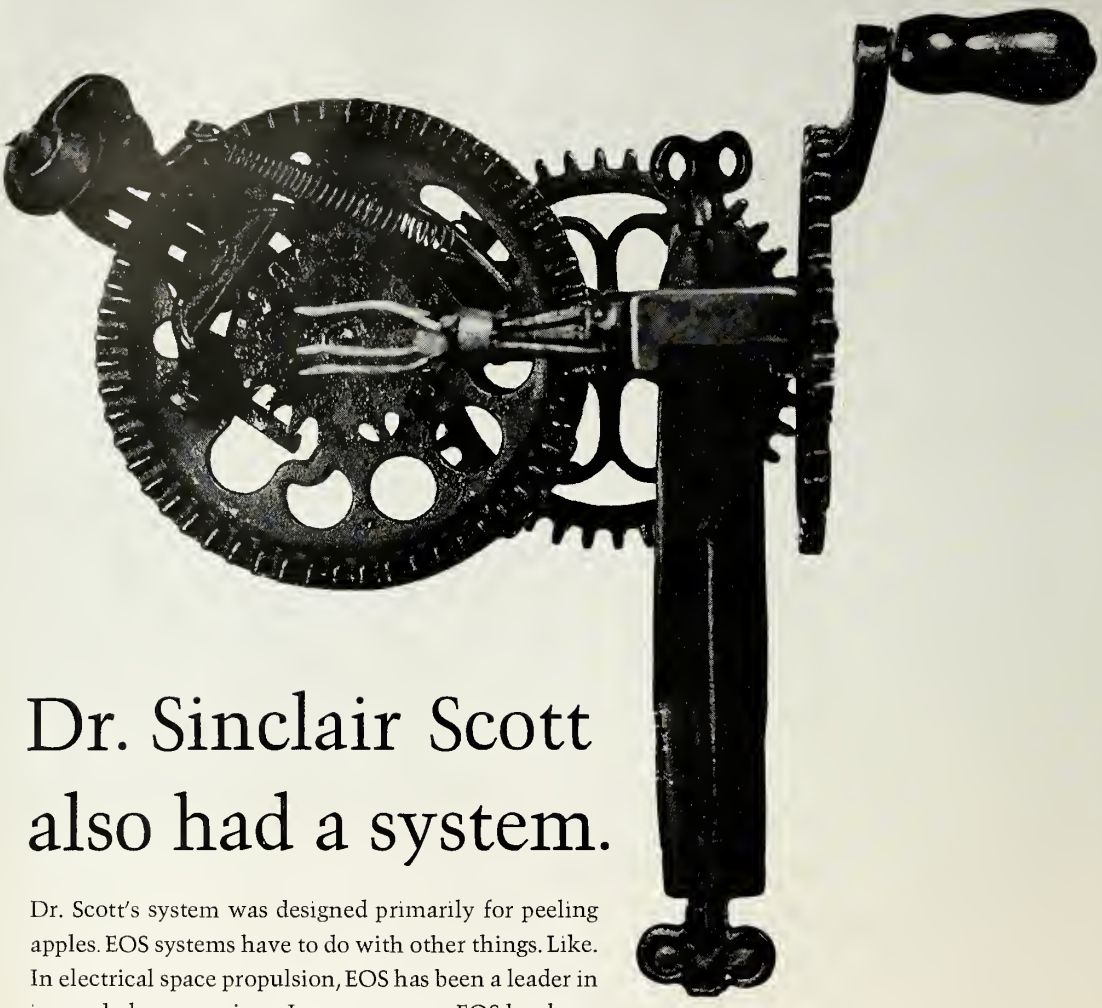


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First Phase of Floxed Atlas Approved . .

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Northrop Choosing M-2, HL-10 Engines .



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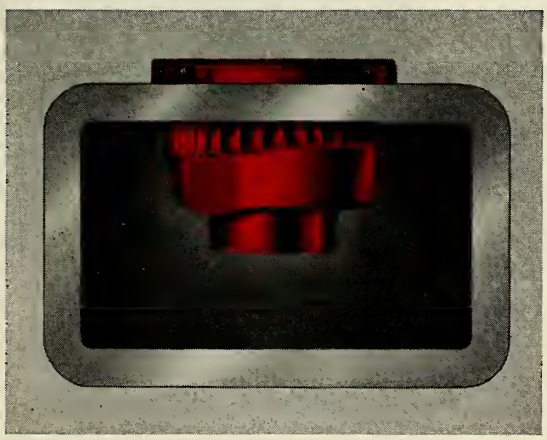
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Traveling the 150 miles between Casper and Jackson, Wyoming, a radio relay system now leaps the towering peaks of the Rocky Mountains. Through a feat of construction ingenuity, up to 480 communications channels are now providing modern communications service.

Atop the mountains, where winter temperatures drop to 50° below zero, three sites for maintenance-free reflectors were needed to bounce microwaves down to relay stations, where the signals are amplified and sent on to the next station.

Supplies for the inaccessible microwave reflectors were assembled in a meadow at the base of the mountains. The rest of the way was virtually straight up and cargo was hauled by helicopter.

Each reflector facing is made up of several panels which were hauled up separately. In addition there were steelwork, sand, cement and water for the concrete footings. For the needed water, the helicopter literally dipped a bucket into a nearby pond.

The installation crew camped on top of the mountain for eleven days. The helicopter made five-minute round trips with the supplies to complete the installation before winter with its severe temperatures and snows.

This unique radio relay system is an example of how the Bell System works to provide normal telephone communications regardless of obstacles. It is this type of capability which builds reliability into the nation's communications system, a vital bulwark of our defense.

Bell Telephone System

American Tel. & Tel. Co. / Western Electric Co.
Bell Telephone Laboratories / 21 Operating Companies

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING | Volume 14, Number 25 | June 22, 1964

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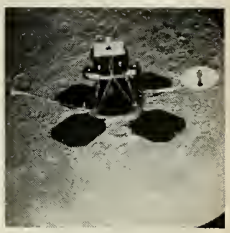
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THE COVER



Scale models of Moon and NASA's Lunar Orbiter, being developed by Boeing Co., show how the unmanned camera-carrying craft will approach to within 30 mi. of the Moon to take high-resolution pictures of the lunar surface. Photos will help determine suitable manned landing sites.

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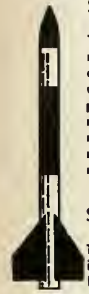
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letters

ESAR by Bendix

To the Editor:

There is an error in James Trainor's article, "Missile Site Radar Paces Nike-X" (M/R, May 25, p. 14). He describes Electronically Steered Array Radar as being built by Sylvania, whereas the equipment was built by Bendix Radio Division. The ESAR facility is still on our test site and intact.

W. W. Price
Director of Public Relations
Bendix Radio Division
The Bendix Corporation
Baltimore, Md.

Pro ESP Research

To the Editor:

In re the item on extrasensory perception ("ESP Communications Potential Raised," COUNTDOWN, M/R, May 18, p. 9):

I doubt that most of the intelligent or highly imaginative among us do not, in enlightened moments, see a little beyond the present existence. However, I feel that extrasensory perception is a rare talent, possessed only by a few exceptional individuals, and that not enough of these have been assembled together in one group to demonstrate (if it is possible) the truth of this "sixth sense."

Moreover, while many ESP events may be described as "coincidental," their effects are no less real and often highly influencing. The documented case of President Lincoln forewarning his cabinet members of his assassination, President Kennedy's preoccupation with getting things done in a limited time—these point to that "telling voice" which surpasses the objective thinking of man. And speaking of Presidents Lincoln and Kennedy, a host of events in their lives were almost too identical to be denounced by skeptics as coincidental.

Man must recognize that he is, after all, cosmic material and is influenced by cosmic events—a plethora of which remain unknown to him. This is why I endorse research in ESP as suggested by Dr. Everett F. Dagle of AFCRL as a possible method of communicating in deep space. After all, we can only conjecture as to what things will be like "way out there," what we will find or discover which, to quote T. Huxley, may ". . . sear the eyeballs."

Ray Benton
Baltimore, Md.

Inventors Should Organize

To the Editor:

I commend your printing the letter from Mr. B. F. Miessner (M/R, May 11, p. 4). It was very significant and informative, and I heartily concur in the author's conclusions. I recommend that we inventors form an "AFofI" (American Federation of Inventors) to end the injustices of imposed "assignment" agreements on the one hand and unemployment on the other. We must begin taking our ideas to Europe and Russia, where we can expect to receive fair treatment.

John H. Bloomer
Manhattan Beach, Calif.

Apollo/Gemini Food

To the Editor:

I would like to comment on the article, "Combined Food Programs for *Apollo* and *Gemini*" (M/R, June 8, p. 36).

1. NAA-SRI main-dish *Apollo* foods are compounded from selected commercially dried individual products. This approach has the advantage of utilizing "off-the-shelf" items, dried by whatever method best fulfills the overall requirements. Freeze drying, despite lay opinion to the contrary, is not an ultimate process. Freeze-dried foods are lower in density and more susceptible to storage degradation than are foods dried by other methods, because of their higher surface-to-volume ratio. These two factors are critical for space requirements.

2. *Gemini* main-dish foods are prepared in the usual way and then freeze-dried. The argument that it is necessary to cook the ingredients together for "flavor" cannot be supported by any of the sensory evaluations made at SRI. I strongly suspect this is a "like grandmother used to make" position.

3. The flapper valve in the SRI bag was conceived and a prototype tested prior to Cooper's flight of May 15, 1963. In addition, the flapper valve, which is torn off after rehydration, but before the food is consumed, has a back-up "Z" valve that prevents loss of fluid from the beverage channel between drinks. The beverage bags may be dropped in a one-g environment without leaking a drop, yet the bag will supply beverages under slight pressure when the Z-valve is flattened between tongue and roof of the mouth during the normal drinking operation. The food bags may also be supplied with this spill-proof valve that will pass bite-size chunks.

4. The basic feeding method as proposed in both the *Gemini* and *Apollo* programs is not just a stop-gap measure to be used prior to the development of a closed-cycle food system using photosynthetic energy. In the hostile environment of space, familiar foods will be among the few physiological and psychological ties to an Earthly environment. We consider this important to the success of extended missions.

It will require less than 600 lbs. of food and packaging to maintain a man for one year in space. At a cost of $500 lb./to target, which is not an unreasonable estimate for post-*Apollo* boosters, the cost for food will be less than $300,000 per man-year in space—an acceptable expense in the exploration of the inner planets.

Richard D. Mathews
Acting Chairman
Dept. of Food Sciences
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Stanford Research Institute
Menlo Park, Calif.

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In the new field of laser communications

LOCAT gets the message—even at outer space speeds!

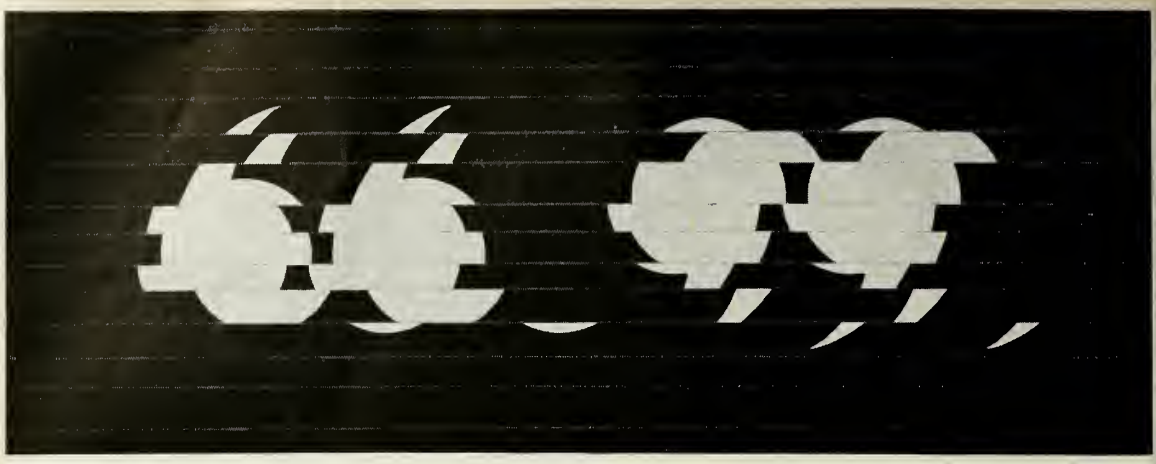
You've heard a lot lately about the use of lasers for line-of-sight communications. A single beam can carry literally millions of messages simultaneously, and with complete security since only the receiving target can intercept the pinpoint beam.

Sounds ideal for earth-to-satellite, or inter-spacecraft communications; but how do you keep the directional laser beam precisely aimed when space speeds of 18,000 mph or more are involved?

Scientists and engineers at Lockheed Missiles & Space Company have found the answer in LOCAT (Lockheed Optical Communications, Acquisition and Tracking System), a combination of laser technology with a unique optical sensor which tracks the beam and maintains communications even when the receiver is in motion. At the same time, the receiver "demodulates" the beam's voice information into intelligent speech. Even video information can be used.

LOCAT is a dramatic example of Lockheed's continued research in the new sciences of sea, sky and space. Quite possibly it may have scientific or practical application in your field; your inquiry is invited. Write to Director of Marketing, *Lockheed Missiles & Space Company, Sunnyvale, California—A Division of Lockheed Aircraft Corporation.*

LOCKHEED



Multipath? Backscatter?



You can forget them with Martin Company's Adaptive RADA System

One key achievement of Martin Company's Adaptive RADA system: the elimination of multipath and backscatter effects which degrade system capacity, distort message transmission in most coded pulse systems.

The secret: a concept which combines the best features of exclusive, adaptive and co-channel signaling techniques. The result: a random access, discrete address system which provides highest subscriber capacity with maximum frequency conservation.

Here's how Martin's Adaptive RADA system works:

1. When one subscriber dials another, the signal is sent by a co-channel technique which activates the addressee's discrete address code.

2. When contact is established, Martin's adaptive RADA system automatically assigns the subscribers to a channel not in use.

3. Since Martin's adaptive RADA system selects **only** channels not in use, all other conversations are excluded from this channel—preventing degradation of voice quality due to multipath.

4. Once the conversation is completed, the channel is automatically freed for other subscribers' use.

Other features of Martin's Adaptive RADA system include:

1. CO-EXISTENCE WITH CONVENTIONAL UHF/VHF COMMUNICATIONS EQUIPMENT—since the adaptive system uses narrow channel signals, they can be more easily assigned to avoid interference with other users, and in case of conflict, the system will automatically "skip" the occupied channel.

2. AUTOMATIC POWER AND LEVEL CONTROL—automatically adjusts transmitter and receiver power to the optimum power necessary to complete the radio link. Thus the same adaptive channel may be used and re-used outside the call's transmission area.

3. AUTOMATIC SEQUENTIAL SEARCH—Martin's range extension transmitters automatically search out and locate any address—lets you dial any subscriber direct, whatever his location, without needing to know his "area code." Overlapping coverage of these range extension transmitters also provides alternate routing whether users are stationary or mobile—increases survivability and reliability of the system.

Martin's Adaptive RADA system has been tested and optimized by computer simulation, laboratory experiment and field testing.

It is another example of how Martin Company's new approach to old communications problems is producing better electronic systems for our country's defense.

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The Countdown

WASHINGTON

Booster Hearings Due to Start

The Senate Space Committee begins consideration this week (June 24) of the relative merits of the nation's boosters (M/R, June 8, p. 13). Witnesses, led by NASA and Dept. of Defense agency heads, will testify behind closed doors.

Space-Power Study Report Delivered

Report of a special NASA-DOD-AEC group studying the space power requirements of the space program from now to 1975 was presented recently to the Joint Aeronautics and Astronautics Coordinating Board. So far, results of the investigation of chemical, nuclear and solar power are classified. But some loosening of the tight rein on the report is expected later, after it has been reviewed by interested agencies.

Zuni Launchers Modified

A new launcher for the air-to-surface *Zuni* unguided rocket will enable Navy attack aircraft to almost double the number of rockets they can carry. The new launcher pod contains seven *Zuni* rockets, whereas the old pod carried only four.

Mariner Choices To Be Made Shortly

NASA top management will decide this week whether the *Mariner* spacecraft for the 1966 fly-by of Mars will be developed by industry or Jet Propulsion Laboratory. Also slated for review is the question of whether a 1966 mission will be sufficiently different and more sophisticated than the 1964 flight to warrant being developed.

Phoebus, Nerva II Will Upstage Nerva

The Phoebus reactor and the so-called *Nerva II* engine will have a thrust three to five times the 50,000 lbs. of the *Nerva* nuclear engine. *Nerva II* is conceived as a powerplant for manned planetary exploration. NASA officials say flight tests of the *Nerva* in a nuclear rocket stage now hinge on the requirements for extended lunar exploration.

Texas Navy Station To Track Satellites

The Navy is reported to be building a satellite tracking station in the Rio Grande Valley in Texas. A transmitting station will be constructed on a 30-acre site and a receiver on a 120-acre site. Total cost is estimated at $2 million.

GSFC Anxious to Get Astronomy Satellite

Goddard Space Flight Center's proposal for a *Radio Astronomy Satellite* will be presented in the near future to Dr. Robert Seamans, NASA associate administrator. It is strongly backed by Goddard and is expected to get program approval as soon as FY '65 funds are available. A request for proposals from industry is expected to follow shortly.

Seating Problem for Gemini Pilots

Zero-gravity flights at Wright-Patterson AFB are raising some disturbing problems for both *Gemini* and *Apollo*, says Martin Debrovner, psychologist and test director. They include difficulty in getting the astronaut back in his seat after he stands up and opens the hatch—an exercise planned for the fourth *Gemini* flight. The seat fits so closely that an astronaut in a pressurized suit can't easily squeeze back down into it while closing the hatch. A seat belt with a take-up reel designed to pull the astronaut snugly into place has been tried but has not yet proved satisfactory.

INDUSTRY

Midwestern NASA Office Considered

The NASA Oversight Subcommittee of the House Space Committee may look into the question of whether a "Midwestern Operations Office" should be established. Some Midwest Congressmen feel that their region is not getting the same advantages available to industry through the space agency's Northeastern office.

NAA Layoff Grows to 2,500

North American Aviation will lay off 2,500 employees of its Space Information and Systems Division by July 1, following completion of certain phases of *Apollo*. NASA had previously announced that it estimated a layoff of 1,000 persons. The larger number results from a further evaluation of changes in the program, and from a cutback in other completed programs, including the paraglider. All types of personnel will be affected.

INTERNATIONAL

Bloodhound Rebates May Be Demanded

Switzerland and Sweden are considering asking for price reductions on the *Bloodhound* missiles they bought from Great Britain. The British government itself secured price cuts from the manufacturer, Ferranti Ltd., after a controversy over the firm's profit level on the *Bloodhound Mk I*. The U.K. report on the episode has been requested by the two neutral nations so that they can decide whether to demand the same rebate. Switzerland is currently using *Bloodhound Mk II* missiles for air defense.

Sergeants Summering in Scotland

The U.S. Army has arranged to have its *Sergeant* missile battalions use Britain's Hebrides firing range for practice this summer. Air Force planes will airlift the weapons, support equipment and troops to the range in the Western Islands, and the British will supply some equipment and support personnel. The Scottish range has been used under similar arrangements by the Army's *Corporal* units in Europe.

French Disclose New Missile Ranges

M. Jean Cahen-Salvador, chairman of Nord-Aviation, has disclosed to French aerospace correspondents the range of the tactical missiles developed by his company in conjunction with *Bölkow* of West Germany. The *Milan* has a range of 1.5 mi., the *Hot* 2.4 mi., and the *Roland* 3.5 mi.

OSSS Pacts Signed

The Air Force has given the green light to three firms to initiate a four-month study effort into orbital space station system experiments commencing June 1. The work will be directed at formulating experiments designed to demonstrate and assess the function of man in space.

The contracts are an extension of studies into the system requirements. The difference since the advent of the *Manned Orbiting Laboratory* program is that the studies will earmark the type of experiment that will readily fit the *MOL* and indicate by exception those needing other vehicles or environments.

Douglas Aircraft will receive $325,000 for its portion; Martin Co. $330,000; and General Electric's Missile and Space Div. will get $333,203.

Soviets Won't Join ComSat

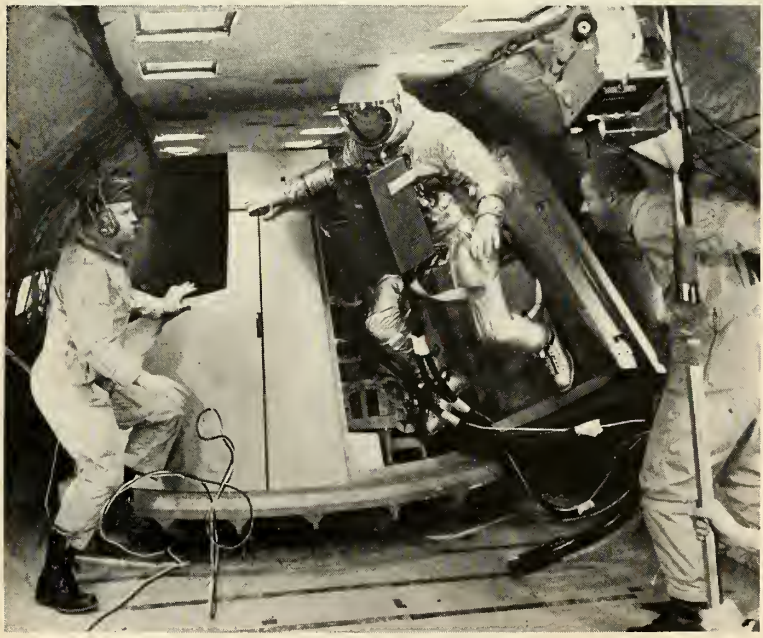
The Soviet Union, after reports that it would join some two dozen other nations in participating in an international communications satellite system utilizing Communications Satellite Corp. facilities, appears to have withdrawn from the scheme during exploratory talks on the subject with U.S. representatives in Geneva.

Despite exhibiting a "friendly interest" in the idea, Soviet officials attending the discussion left without committing the USSR to participation in it.

No further meetings on the subject between representatives of the two countries have been scheduled. U.S. talks with other countries have resumed, and there is considerable optimism that the international system will materialize in the near future.

Pluto Funds Cut

A Congressional committee has wiped out most of FY 1965 funds for Project Pluto in the Atomic Energy Commission budget. The action apparently will force a showdown on the future of the program.



Testing Gemini Egress in Weightlessness

ENGINEER-PILOT from McDonnell Aircraft Corp. emerges from McDonnell/NASA Gemini spacecraft mockup during weightlessness. The 22-second egress test took place aboard an Air Force KC-135 jet equipped for zero-g training and operating from Wright-Patterson Air Force Base, Dayton, Ohio. Test was one in a continuing series.

The House Appropriations Committee cut an additional $5.5 million from the original $8 million request, which already had been trimmed by $1.5 million by the Joint Atomic Energy Committee. This leaves only $1 million in AEC's budget for the project, which the committee said was for the purpose of "moth balling" it until the time a military system and requirement are shown.

The real crisis may come in the next few weeks when the Dept. of Defense Appropriations Bill is considered by the Senate Appropriations committee. An additional $12 million for Pluto remains in the DOD request. The committee can be expected to delete these funds, unless DOD puts forth a requirement for the project.

The lack of a military requirement or system for the Tory II-C reactor and the fact that no engine system or vehicle has been developed to carry it were cited as reasons for cutting funds for the program. The House Appropriations Committee said that the successful May 20 test of the Tory II-C reactor "amply demonstrates the successfulness of the ramjet propulsion reactor power plant."

In other actions on the AEC budget, the House committee applied a $900,000 cut to the nuclear reactor category on the basis that it will be "readily absorbed on the basis of past experience with estimate underruns." No specific cuts were made to the *Rover* or SNAP programs.

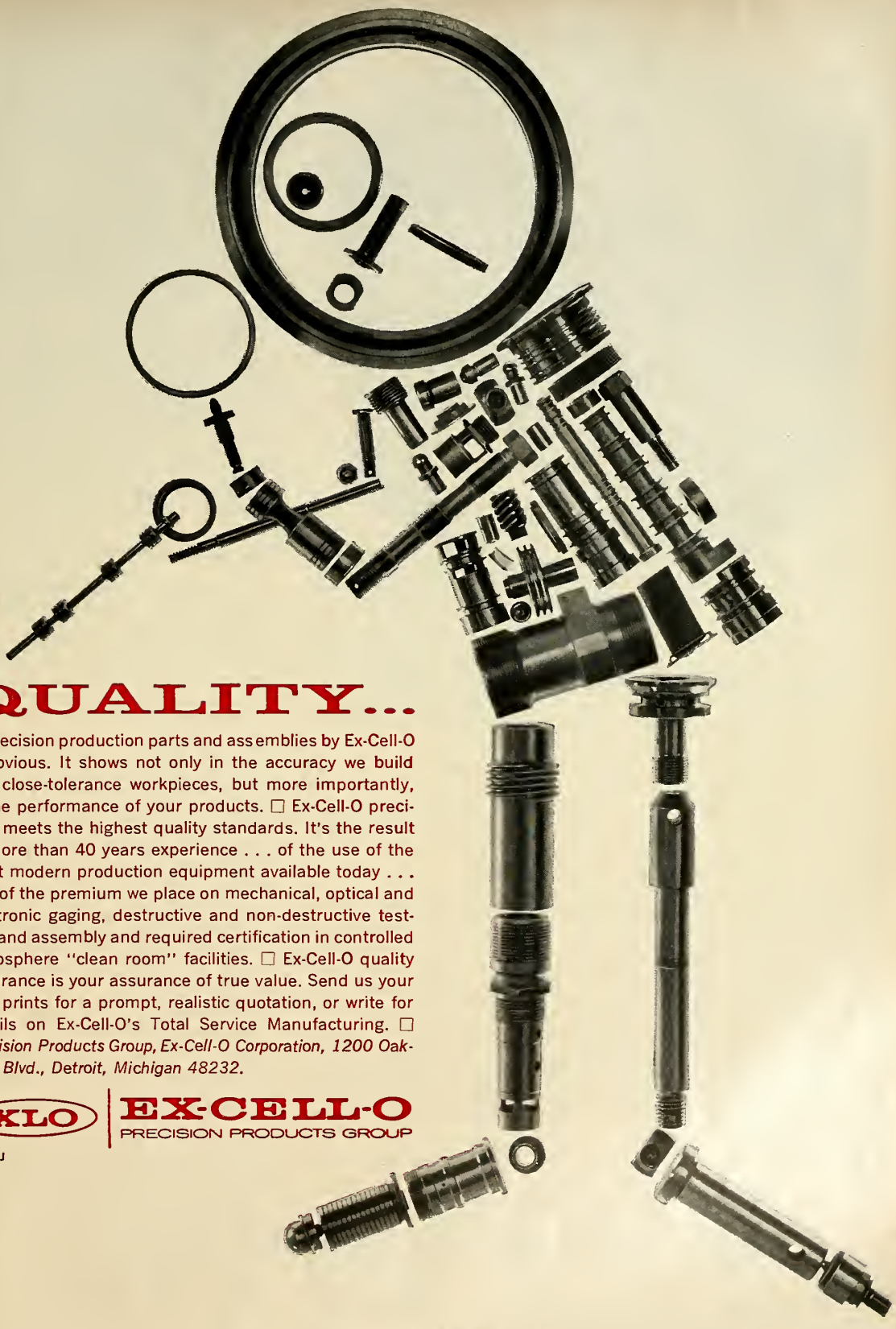
Total funds cut from the AEC request of $2.32 billion are approximately $69 million, almost $8 million of which was previously acted upon by the Joint Committee. The Appropriations Committee also added cuts of $6.7 million in weapons, $2 million in biology and medicine, and $8 million in physical research.

NASA Funds Saturn Study

The space agency has announced a program to study the uprating of its *Saturn V* booster, including the possibility of a new high-pressure liquid hydrogen engine with a thrust of 300,000 to 350,000 lbs.

The feasibility study of the engine was part of a package of nine study contracts with a total cost of $2 million, which are expected to be awarded before the end of the month.

Each of the three-stage prime contractors has been named on a



QUALITY...

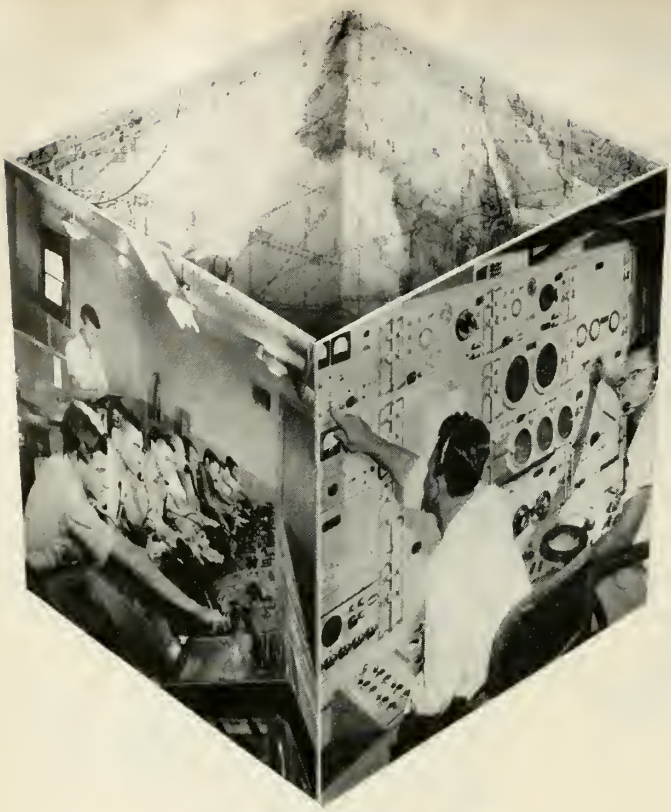
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An important adjunct to this facility is the Real-Time Computer Center having a fail-safe dual computer system capability, including 2 CDC 3600's. It will compute instantaneously the impact point of ballistic missiles, the predicted orbit, apogee and perigee of orbiting vehicles, and provide acquisition data for down-range stations.

For the first time independent control of range support for simultaneous countdowns of two missile launchings and ETR support for an orbiting space vehicle will be possible.

On this and other programs providing range support for the nation's space and missile programs...over 40 scheduled in the next five years...assignments are now open in Range Planning, Systems Engineering, Systems Management, and Range Operations for graduate engineers experienced in: Pulse & CW radar / telemetry / infrared / data handling / communications / closed circuit TV / frequency analysis / command control / underwater sound / timing / shipboard instrumentation / meteorology.

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sole source basis to study uprating its stages by redesigned propulsion systems, improved vehicle performance and engine improvements. This includes The Boeing Co., for the first stage; North American Aviation, Inc., for the second stage; and Douglas Aircraft Co. for the third stage. In addition, Rocketdyne Div. of NAA will study uprating of the F-1 and J-2 engines.

Three other contracts will be awarded to study the addition of solid strap-ons to the first stage. One involves the use of the 120-in.-dia. solid motors, with Boeing, General Dynamics/Astronautics and the Martin Co. competing.

The only firm submitting proposals for the two other studies was Boeing. One contract calls for an overall appraisal of the effects of solid strap-ons—in terms of cost, scheduling and impact on the *Saturn* program. The other study of solid strap-ons involves fluid and flight dynamics of the improved version of *Saturn V*.

Collins Gets Apollo Contract

Collins Radio Co.'s Dallas Division has been selected to produce a major portion of the unified S-Band tracking, data acquisition and communications system to be used in Project *Apollo* manned space flights.

The contract will be worth approximately $20 million, NASA announced.

Nine systems with 30-ft.-dia. parabolic antennas will be provided. Six of these are planned for integration into facilities already being improved for Project *Gemini* two-man Earth orbital flights, and three are planned for new *Apollo* ground stations.

Some 30 partial systems will be incorporated with other station equipment at these and other stations for the additional demands of the *Apollo* flight program, including the lunar flights.

The contract is to be a fixed price type with incentive features.

Grumman Expects OAO Award

NASA is negotiating with Grumman Aircraft Engineering Corp., for fabrication of a third *Orbiting Astronomical Observatory (OAO)* and an option for two more.

The third spacecraft, designated *OAO-C*, will have the same basic design as the *OAO-B* being developed by Grumman as prime contractor for the current *OAO* program.

Value of the contract is expected to be in excess of $20 million if only

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the *OAO-C* is acquired and in excess of $50 million if the other two new versions are purchased. An incentive-type contract is under consideration.

The observatories will serve as stabilized platforms capable of being pointed by ground control so that long-duration studies can be made of such subjects as mapping and studying the characteristics of the stars, planets, nebulae, and interplanetary and interstellar environment in the relatively unexplored infrared, ultraviolet, X-ray, and gamma-ray regions of the spectrum.

Avien Loses Apollo Contract

North American Aviation spokesmen say that cancellation of a $2.8-million NAA contract with Avien, Inc., for the *Apollo* S-band high-gain steerable antenna system will not affect the *Apollo* program schedule.

Avien, along with its subcontractors, Barnes Engineering and United Shoe Corp., had been awarded the contract by NAA last July.

The system is designed to be the main communications link between Earth and the Command Module, at distances beyond 8,000 mi., and will not be flown prior to the Block II *Apollo*. Therefore, it is thought there will be enough time to get a new contractor without delaying that part of the program.

Cape Temporarily Normal

A Federal District judge issued a temporary restraining order against picketing at Cape Kennedy on June 16, and then extended its effect to 5 p.m. (EST), June 19.

Judge George Young of the Federal District Court in Orlando, Fla., issued the order after mediators of the National Labor Relations Board appealed for an injunction to remove the Florida East Coast Railway workers picket line that had resulted in 80-90% of the Cape Kennedy-Merritt Island Launch Area workforce staying off the job for three days.

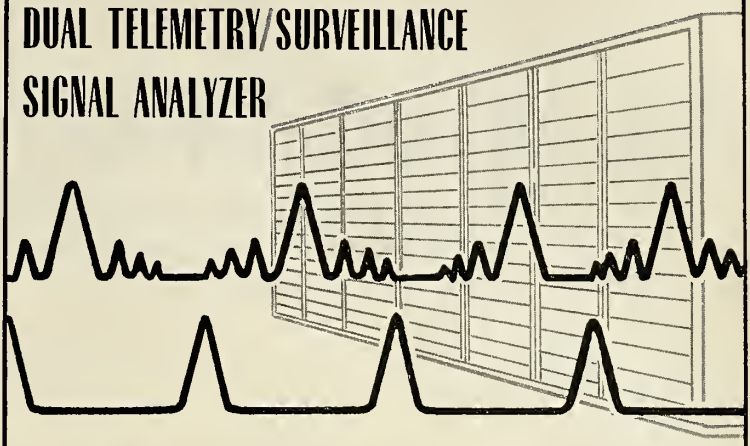
A further declaration was expected from Judge Young prior to the expiration of the injunction.

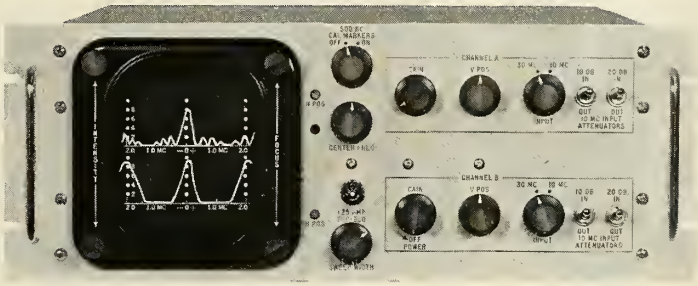
Shots of the Week

The Air Force successfully launched two *Minuteman* ICBM's from Vandenberg AFB, Calif., June 11 and 15. The shots were the 48th and 49th launches of the missile from that West Coast base. Both were routine training flights aimed at targets 5,000 mi. down the Pacific Missile Range.

WATCH DEI

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- **Provision for 10 mc and 30 mc input**
- **10 kc Resolution**
- **4 mc Sweep Width**
- **5 inch CRT**

Significant advances have been engineered into this double-duty signal display and analyzer unit . . . the SA-101 Signal Analyzer from Defense Electronics, Inc.

Capable of monitoring a 30 or 10 mc input frequency, the unit is particularly useful for work with predetection telemetry equipment. It permits simultaneous viewing of any two of four available signals (two 10 mc or two 30 mc signals or any combination).

The latest in DEI's SA display series, the SA-101 also provides greater sweep width . . . from 0 to 4 mc; with better resolution . . . 10 kc; larger and brighter display; and bigger . . . five-inch dual gun . . . CRT with calibration markers. The 2-in-1 display package also saves precious ground station telemetry receiving system space—yet is versatile enough for connection to ordinary oscilloscopes for remote displays.

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Floxed Atlas Phase I Approved

Webb decision, combined with go-ahead for Phase II and successful AC-3 launch, would speed unmanned flight program

by Hal Taylor

NASA ADMINISTRATOR James E. Webb has approved Phase I of the Floxed *Atlas* launch vehicle development program.

The first phase—at a cost of $5 to $8 million—calls for engine component tests and firings of the *Atlas* sustainer engine. Phase II—which is expected to be approved late this year—includes static firing of Floxed *Atlas* engines on two boosters left over from Project *Mercury* and the purchase from General Dynamics/Astronautics of a flight-configuration vehicle for a flight test.

The official go-ahead for the program was learned by MISSILES AND ROCKETS as the space agency announced plans to launch its third *Atlas/Centaur* vehicle no earlier than June 25. If successful, it will be the second straight for the liquid hydrogen *Centaur* and a major advance in the unmanned spaceflight program.

The Floxed *Atlas/Centaur* combination would be used to boost the heavy 2,500-lb. *Surveyor* spacecraft to the Moon and *Mariner* spacecraft to Mars.

Adding fluorine to the liquid oxygen in the *Atlas* engines will increase its performance by some 30%.

● **New facility hurdle**—NASA officials said a decision on the second phase of the program was put off because top management is reluctant at this point to allocate funds for the new facilities that will be required. They want to wait until the results of Phase I are in.

Another reason for the delay in initiating the static firing and flight test portion is the continued study of the *Titan III* as a space booster for unmanned programs.

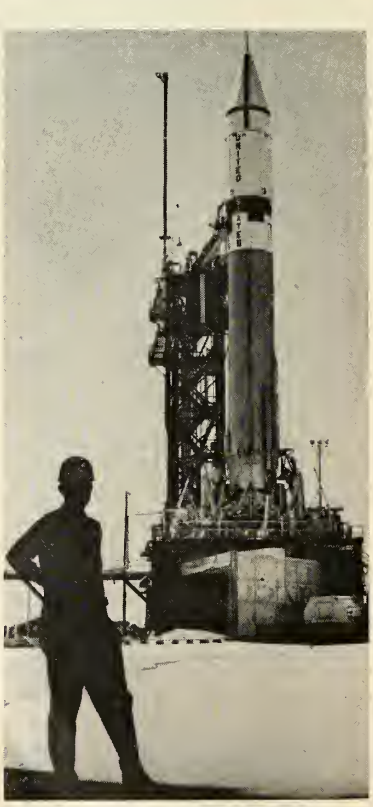
Officials close to the space science launch vehicle program said, however, that the chances for approval of Phase II are very good.

Total cost of the two-stage program is estimated at $40 million, with the funds split between GD/A, prime contractor for *Atlas*, and Rocketdyne div. of North American Aviation, Inc., developer of the booster's engines. The test facilities for the static tests are expected to be built at Edwards Air Force Base, Calif.

A successful *AC-3* flight would be another spur to approval of Phase II. The *Centaur* upper stage has been plagued by problems and is now more than two years behind schedule.

After its first lauch attempt failed, it was successfully launched for the first time last Nov. 27.

Another success will indicate that its technical problems are licked and that the *Atlas/Centaur* combination can be counted on to become a workhorse booster in the U.S. space program.



MATED ATLAS/CENTAUR at Cape Kennedy awaits launch no earlier than June 25.

● **AC-3 profile**—*AC-3* will be similar to the flight last November, in which the *Centaur* went into orbit with an apogee of 1,100 mi. and a perigee of 295 mi.

During the *AC-3* flight, however, the second-stage insulation panels and a *Surveyor*-type nose fairing will be jettisoned after *Centaur* passes through the Earth's atmosphere.

In addition, after a six-minute burn of the *Centaur* engines and a coast period, the RL-10 engine boost pumps will be restarted to determine that propellants are sufficiently "bottomed" in their tanks so that the engines could be ignited again. Restarting the engines is not planned, however, until *AC-4*.

On *AC-3*, the single burn of the *Centaur* engines will insert the empty second stage—weighing about 8,200 lbs.—into an elliptical orbit with an apogee of 3,600 mi. and a perigee of 340 mi. The apogee will be higher than that of *AC-2* because jettisoning the insulation panels and nose fairing greatly reduces the weight of the *Centaur* stage by the time the RL-10 engines ignite. Achievement of orbit, however, is not an objective of the *AC-3* flight.

This third test flight originally was scheduled in April. It was postponed for redesign of the insulation panels and further testing of how they are jettisoned after *Centaur* has climbed above the atmosphere.

In early tests, it was found that air between the panels and the tanks, containing the liquid hydrogen fuel at —423°F, froze solid causing the panels to stick. A system using helium gas to purge air from between the panels and tank wall was modified, and successful panel jettison tests were completed at Point Loma, Calif., before the *AC-3* flight was rescheduled. ■

Tighter Control Over JPL Urged In Report of House Space Committee

A TOUGHER POLICY on the part of NASA toward Jet Propulsion Laboratory has been evidenced by a stringent and unprecedented on-the-spot checkout of the *Ranger VII* spacecraft by top space agency officials.

Associate administrator Homer E. Newell, deputy associate administrator Edgar Cortright and lunar and planetary programs manager Oran E. Nicks flew to JPL's Pasadena, Calif., headquarters last week to conduct the examination.

Strong measures were also urged by the House Science and Astronautics Committee in its report on the NASA Legislative Oversight Subcommittee's probe of Project *Ranger*. These included a recommendation that NASA sign only a one-year contract with Jet Propulsion Laboratory. The planned contract is expected to run three years.

The committee said it concluded from NASA's request that JPL begin operating in accordance with the new contract before it is signed that "these actions cannot reflect anything other than an embarrassing unwillingness on the part of JPL to submit to NASA direction in the past. This extraordinary show of independence on the part of a contractor operating a Government facility and doing approximately a quarter-billion dollars worth of business per year for NASA is considered the most significant fact developed during the subcommittee's investigation of Project *Ranger*."

The subcommittee, which was chaired during the probe by Rep. Joseph Karth (D-Minn.), also recommended that:

—NASA should determine, with respect to each project now assigned to JPL, whether the Laboratory is performing the services of a NASA center or a major contractor, and then arrange to provide management control and supervision appropriate to that role. The committee indicated that its own feeling was that the Laboratory is better suited to the role of a NASA center.

—NASA should install a general manager, "experienced in industrial operations and supported by an adequate staff" at JPL as Deputy to the Director, to manage such complex in-house projects such as *Ranger* and *Mariner*.

—NASA should reform its present relationship to JPL so as to a) establish a strong and recognizable chain of command, b) accomplish direct, detailed, and continuous supervision of activities at JPL, and c) achieve responsiveness on the part of JPL to NASA direction.

by Heather M. David

In an official statement issued in Washington, NASA administrator James E. Webb said only that "we will go fully into the recommendations with CalTech and JPL, and we feel sure that the Committee on Oversight will be satisfied with the action we take."

● **Both rapped**—NASA and JPL shared equally in the criticism levied by the committee. The group said that "serious management deficiencies have existed both at JPL and at NASA headquarters apparently during the entire course of the project."

Although it cited the advanced nature of the project as contributing to the difficulties, the subcommittee said that it "reluctantly concludes that the weaknesses in management of the project at JPL and NASA headquarters have been of such substantial nature as to strongly suggest that management failures have, in fact, adversely affected the success of the project."

The subcommittee emphasized that it was not attempting to fix personal blame or individual responsibility for the lack of success, but pointed out that "someone representing the Government must assume personal responsibility for making the hard decisions necessary to satisfactory progress and ultimate success."

NASA's management techniques relating to JPL were scored by the committee, which termed "minimal" the technical monitoring of JPL in the performance of its work on the *Ranger* project.

NASA officials were quoted as saying that if NASA were monitoring the *Ranger* project at JPL in a manner similar to the way a typical contractor is supervised by a NASA Center, "it would be necessary to assign an additional 150 technical and administrative Government personnel at NASA headquarters." Since, in connection with *Ranger*, JPL operates more as a contractor to NASA than as a center, the committee intimated, "the inadequacy of the present arrangement with JPL on Project *Ranger* is patent."

● **Testing criticized**—The subcommittee said that in the light of all the evidence, it "is forced to conclude that progress in improving testing and fabrication techniques at JPL is a step-by-step process with little direction from NASA headquarters and that major improvement actions take place primarily as a result of failures."

The Karth subcommittee cited recommendations for more rigorous testing, which had been made in the earlier Kelley report, and said that in spite of these, "it was apparent . . . that a rigid and thorough testing policy had not yet been established." However, the group indicated that blame for this might be laid to organizational difficulties at JPL, and "the lack of specific direction from NASA headquarters to JPL on the establishment of specific standards of testing and quality assurance."

The group further called for a thorough investigation of every possibility of failure prior to committing the *Ranger* spacecraft to launch, saying that it found it difficult to believe that JPL has done this. Purpose of the investigation would be to develop a comprehensive testing philosophy, "which could be applied through every phase of the *Ranger* spacecraft program and would promise a greater probability of success in future *Ranger* launches."

The subcommittee concluded by saying that "increased use of systematic, thorough and pragmatic management and supervisory practices as currently in use throughout the missile-space industry would go far to develop improved testing and fabrication procedures needed. . . ." ■

Apollo Experiment Deadline Nears

HOUSTON.—Scientists have a little more than six months to propose scientific experiments for the first Project *Apollo* landings on the Moon.

This is the advice given to 30 leading scientists invited to the Manned Spacecraft Center here to discuss the Project *Apollo* lunar exploration.

A timetable presented by Jack Eggleston, chief of the Space Environment Div. at MSC, called for final experiment negotiations starting in January, 1965.

Eggleston said the devices should be qualified for flight by early 1969.

Elbert King, geologist at MSC, said studies of lunar surface working conditions indicate that each astronaut may be able to make two trips outside the Lunar Excursion Module (LEM).

● **Time limit**—Three hours represents the maximum time allowed on each traverse of the lunar surface, he said. This is the planned capability of the back pack that carries the astronaut's oxygen, cooling and air-cleaning system.

King estimated the maximum distance an astronaut could wander from the spacecraft would be approximately 1,000 ft.

One of the astronaut's jobs will be to place a 10-ft. parabolic antenna near the LEM as a radio-TV relay link to Earth. One of the last tasks will be to move the antenna beyond blast range of the LEM ascent engine.

The four-day conference was attended by more than 70 NASA and MSC scientists and engineers, in addition to the university and industry scientists invited.

● **Optimizing exploration**—Dohn Dornbach, MSC selenologist, advised the scientists that experiments must make maximum use of the astronauts' time on the surface. *Apollo* flights will come with a frequency of three to six months, he said.

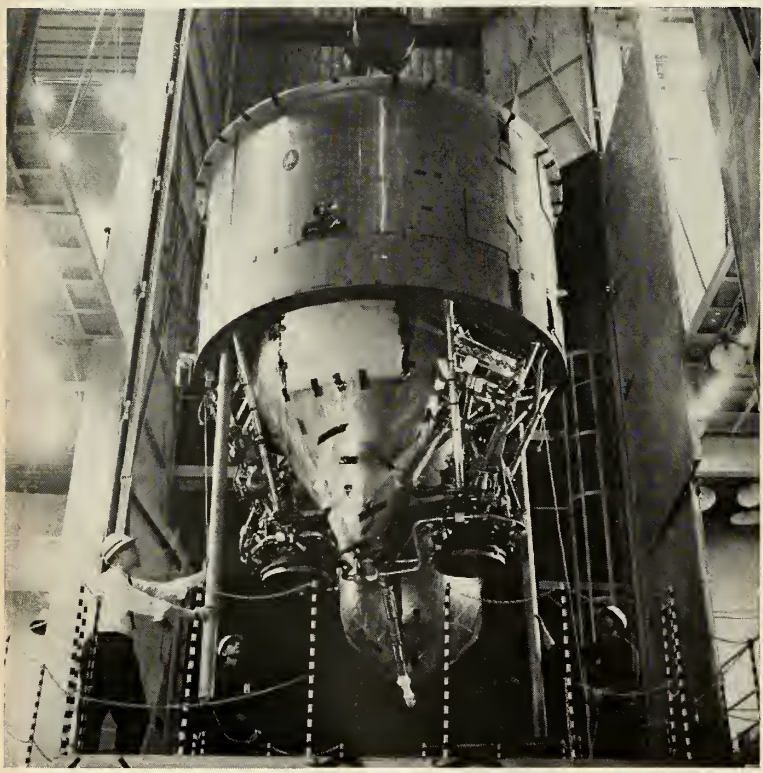
Dornbach said he wanted to clear up a misunderstanding in the scientific community about an MSC contract with Texas Instruments, Inc., for a study of scientific experiments on the Moon. "It was never our intent to specify what payloads would be put on the *Apollo* spacecraft without consulting the scientific community," Dornbach said.

The Texas Instruments contract was designed as a survey of all the probable experiments that would be recommended for Project *Apollo,* he said. The final report is due Aug. 30.

● **Payload considerations**—Rene Berglund, spacecraft engineer, said that lunar orbiting survey missions could guarantee scientists an excess of payload capability.

"It's really up to the scientists to generate the demand for these missions," Berglund advised. Payload for a 14-day mission in polar orbit around the Moon runs about 20,000 lbs., Berglund said.

Camera systems now under study for the orbiting mapping mission should resolve objects as small as 2 ft. across, he continued. Tight resolution cameras will cover 300,000 sq. mi. in a 14-day flight. Cameras of lower resolution, with 182-degree coverage, can map 7,000,000 sq. mi., or one-fifth of the total area of the Moon in a single mission. The coverage could be larger except for the desire to restrict photographs to areas where the Moon is lighted exactly right for best definitions and the need to keep the payload returned to Earth within an 80-lb. limit. ■



Titan III Transtage Readied for Tests

AIR FORCE Titan III Standard Space Launch Vehicle Transtage is being prepared for tests conducted at Martin Co.'s Denver Div. vertical test facility. Transtage, which develops 16,000 lbs. of thrust, is a new upper stage developed for the vehicle. Bell-shaped thrust chambers that appear between fuel tank (rear) and oxidizer tank will have skirt extensions added for flight. The Denver Div. manufactures the Titan III airframe and is systems integrator under AFSC direction.

Potential users not excited . . .

NASA Seeks Establishment Of Navsat Study Committee in a Month

Space agency meetings with FAA, Commerce, Defense, Interior departments generate optimism about ad hoc group's formation

NEW YORK—NASA officials expect to get interested government agencies to sign an agreement setting up an ad-hoc committee to study the needs and requirements of a civilian navigational satellite system in about a month.

The optimistic outlook prevails despite indications of only lukewarm interest by potential users of the proposed system.

NASA officials, however, have been meeting with representatives of the Federal Aviation Agency (FAA) and Commerce, Defense and Interior Departments to reach agreement on setting up the committee. "It is our understanding," the officials said, "that the ad-hoc group is in the offing in the near future."

The mild interest in the system by potential users was evident during a panel discussion at the Institute of Navigation meeting where missile/space firms offered a wide range of systems—from a single satellite in synchronous orbit to systems employing as many as 24 satellites in random orbit.

● **Who needs it?**—An example of the thinking of potential users was the comment of Siegbert B. Portizky of the Air Transport Assn. that "the Navsat was a glorious solution in search of a problem." Robert J. Shank, FAA Associate Administrator, cautioned that his agency has $200 million invested in air navigation equipment and that any future system must build on existing equipment.

Robert A. Fish of the Science & Technology Div. of the Dept. of Commerce expressed disappointment because the firms making presentations seem not to have moved far enough ahead in prehardware work during the past year.

Shank, however, did point out that the Navsat system lends itself to low subscriber charges. Based on preliminary projects of the system's cost, he estimated that each navigational fix would cost the user about fifty cents.

James W. Campbell of Technology Audit Corp. also argued that more than 25,000 flight hours are devoted annually to air search and rescues, and that many of these could be saved if a system were available to accurately determine the point location of the accident.

The comments came both before and after presentation of the proposed systems by missile/space firms.

● **The proposals**—The six systems proposed are the RCA version of *Transit*, known as *SONG* (*Satellite for Orientation, Navigation and Geodesy*), using Doppler shift measurement techniques from 12 to 24 satellites; the Westinghouse synchronous orbit single satellite system using the interferometer technique; a Collins angular navigation satellite that serves as a man-made star for celestial navigation.

Also, the GE 16-24 pulse repeater satellite system to provide range measuring data from any pair of satellites; the University of Michigan technique known as *LOCATES* (*Location of Air Traffic Enroute by Satellites*), which measures range from two satellites, both stationary; and Cubic's adaptation of its *SECOR* satellite, known as *CODA SECOR* (*Consolidated Data Sequential Collection of Range*), in which multiple satellites provide phase angle measurements. ■

AF Testing New Satellite Inspector

AN EXPERIMENTAL device for possible use as a satellite inspector has been built for the Air Force Systems Command by Ling-Temco-Vought's Astronautics Division, Dallas.

Known as the *Remote Maneuvering Unit* (*RMU*), it is designed to be launched from a manned orbiting mother craft, conceivably a *Gemini* spacecraft. It carries a television camera that can be used to examine other nearby objects in space.

As it is maneuvered about another space vehicle, the *RMU* would televise its image to the mother ship's crew.

Air Force engineers say the *RMU* could be used to inspect either unknown or known objects for scientific observation. The spaceship crew has radio control of the *RMU*, which also is guided by visual sighting and by television.

The LTV Astronautics Div. built the *RMU* for AFSC's Research and Technology Division's Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio. The system weighs less than 125 lbs. and measures 29 x 26 x 10½ in.

Weightlessness tests are proceeding aboard a specially equipped aircraft at Wright-Patterson. Tests in space, say AFSC officials, will begin in "the not-too-distant future."

The device would be stored aboard a manned spacecraft and carried aloft into orbit. There, a target, such as an inflatable balloon or expendable sphere, would be ejected and drift away from the mother craft.

At this point, astronauts in the mother craft would launch the *RMU* and guide it by radio to intercept and maneuver about the target. After completing its surveillance, the *RMU* would be brought back to the mother craft and readied for another scouting mission.

In space, the *RMU* would use hydrogen peroxide as a propellant, ejected from one of more than 16 nozzles on the craft. Remote maneuvering is by means of a radio link, which controls three gyros and the gas nozzles for the *RMU's* propulsion and attitude controls.

Part of long-term effort . . .

Northrop Ready to Pick Engines For M-2, HL-10 Lifting Body Studies

Firm building gliders for NASA program will choose rocket engine next month; details of both spacecraft configurations

by Russell Hawkes

Los Angeles—By mid-July NASA's Flight Research Center plans to select a rocket engine to power the M-2 and HL-10 lifting-body research gliders being constructed by Northrop Corp., Norair Division.

Paul Bikle, director of FRC, told Missiles and Rockets that the engines are to accelerate the two manned flying mockups to Mach 2 for investigations of the handling qualities of the re-entry vehicle shapes in the transonic speed range. "The maximum altitude they reach will not be very high," he said, "maybe 70,000 or 80,000 ft."

Air Force Systems Command is discussing the possibility of taking part in the ultra-low-cost NASA program or setting up a parallel program to evaluate the SV-5 lifting-body shape invented by Martin Company aerodynamicists. No Air Force decision is likely before next fall, when Fiscal Year 1965 appropriations will be available.

FRC has instructed Norair to begin considering which available engines would be most suitable for the M-2 and HL-10 research vehicles. Bikle believes it desirable but not essential that the engine selected be throttle-controlled or restartable. It is not likely that a new engine will be designed for the job because of the program's low budget.

Off-the-shelf engines being considered are the Rocketdyne AR-2, which powers the Lockheed NF-104 aerospace trainer; the Thiokol XLR-11, which was used as an interim engine in the North American *X-15; Titan III* transtage engines being developed by Aerojet and United Technology Center; and *Apollo* Lunar Excursion Module engines being developed by Rocketdyne and Space Technology Laboratories.

● **Select staff**—Northrop is designing and building the two research vehicles under a contract for the very low sum of $1.2 million. The company expects little or no profit from the M-2/HL-10 program but believes its position in the space business will be significantly strengthened by the experience.

To accomplish the program under such tight funding, Northrop has set up a "skunk works" project organization with a very small staff of high-quality people. The average experience of engineers and shopworkers on the M-2/HL-10 program is 20 years per man. In comparison with statistics of past programs of similar size, the 60,000 engineering man-hours and 69,000 production man-hours allocated to M-2/HL-10 is only a half or two-thirds of what would normally be expected.

M-2 and HL-10 engineering and production facilities are co-located for ease of communication and segregated from the rest of the Norair plant to minimize interference. Engineering release procedures and all overhead paperwork routine have been chopped to a minimum. Highly skilled experimental shop technicians will manufacture components from a pre-release assembly drawing, a sketch, or even verbal instructions. No detail drawings will be made.

Northrop's involvement in the M-2/HL-10 program is part of a long-term, company-wide interest in lifting re-entry, which the firm sees as a major product field for the future. The first operational use is expected to be for Earth-orbit ferries. Northrop terms its total effort in this field Project Hy Leap (Hypersonic Lifting Entry Aerospace Program). It includes Air Force-funded studies of hypersonic flow fields and control devices, as well as other investigations paid for as "overhead technical activity."

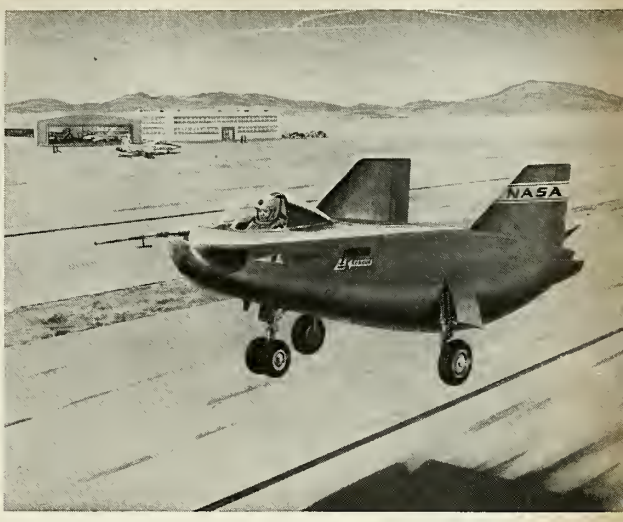
● **Maximum simplicity**—The M-2 and HL-10 research vehicles will have nearly identical systems, to minimize the amount of engineering that must be done. They will also have about the same weight. They will not be optimized designs in any sense. By making the designs highly conservative, it is possible to skip a lot of testing and analysis, thereby saving time and money.

Nearly all the systems and components used in the gliders were designed and made for production aircraft. These have the advantage of immediate availability and demonstrated reliability. Thus, the nose landing gear is from the North American T-39, the main landing gear are from the Northrop F-5A, and the main wheels and brakes are from the Northrop T-38.

All systems are designed for 30 minutes of free flight plus an hour of captive flight while mounted on the *X-15* pylon under the wing of the B-52 mother ship. During captive flight, electrical power and air or oxygen for the pressurized cockpit are supplied through umbilicals from the B-52. Pressurization gas—probably compressed air—will also be stored on board. Maximum cockpit pressure differential will be 10



ARTIST'S CONCEPT shows Northrop-built NASA HL-10 lifting entry vehicle being dropped from B-52 mother ship. Note adapter allowing HL-10 to be carried under X-15 pylon.



NORTHROP-BUILT NASA M-2 lifting entry vehicle lands at Edwards AFB, Calif., in another drawing. Landing gear is gravity-dropped. Wooden predecessor has fixed landing gear.

psi, according to Northrop engineers.

● **Shapes**—The M-2 and the HL-10 are both triangular in planform and "D"-shaped in cross-section. In the M-2, the straight side of the "D" is on top and in the HL-10 it is on the bottom. The latter shape is thought to have a slightly better Lift-Drag ratio. The FRC flight test program will include between 50 and 100 actual flights and both vehicles will be tested in the full-scale wind tunnel at Ames Research Center.

The M-2 will be delivered in April, 1965, and the HL-10 in October, 1965. First flights of each will take place a month or so after delivery. The initial flights will be unpowered glides from 45,000 ft. to the dry lake bed at Edwards.

Two spherical ballast tanks capable of holding 4,000 lbs. of water will be carried in each vehicle so that low-speed handling tests and landings can be conducted at gross weights ranging from 4,000 to 8,000 lbs. The ballast tanks will be pressurized to make it possible to jettison all the water within 30 seconds in event of an emergency. Variations in gross weight will help FRC engineers learn how stability and damping characteristics of the unusual aircraft are affected by variations in area loading and mass. They will also change speed and sink rate but not Lift-Drag ratio.

The landing gear are designed for a maximum sink rate of 13 fps. The water ballast tanks are sized correctly to serve as propellant tanks when the rocket engines are installed, and the ballast jettison pipes roughly parallel the future propellant lines.

● **Controls**—Flight controls of the HL-10 consist of one ordinary rudder and a pair of thick, blunt-edged elevons. Those of the M-2 are less conventional. They are a pair of thick rudders and thin elevons hinged at the upper edge of the wingless body's boat tail. Since the location of these prevents them from supplying a sufficient downward pitching force, they are augmented by pitch flaps at the lower edge of the boat tail.

The body-mounted surfaces of both vehicles will be of sandwich structure, to cope with high acoustic loads generated by the rocket engine.

The pitch flap arrangement on the M-2 research craft would not be satisfactory for an actual hypersonic reentry vehicle because of the high rate of heating to be encountered. The same objection applies to the present location of the canopy, but for the purposes of the FRC program it is unimportant.

A full-powered irreversible dual control system is used in both craft. It is a series-function control loop with stability augmentation on all three axes. The peculiar shape of the M-2 vehicle offers an unusual sort of control system redundancy. The rudders supply roll power about as effectively as the elevons.

The control system is hydraulically actuated with pressure supplied by battery-powered d-c pumps. The silver-zinc batteries were selected as the primary power source, despite lesser growth potential and a 120-lb. penalty in landing weight, because they were found to be far cheaper and more readily available than any auxiliary power unit.

Part of Northrop's assignment is to make an adapter for the *X-15* pylon under the wing of the B-52 mothership. It had been thought necessary to build a separate adapter for the M-2 and the HL-10 because the two should be mounted in different attitudes. However, it was found possible to make the adapter adjustable. It is a combination box-beam and truss structure with an aluminum fairing enclosing air and electrical lines and gas storage bottles to pressurize M-2/HL-10 ballast tanks to 3,000 psi.

● **Instruments**—Cockpit layout of the two vehicles is dictated by their Delta planforms—calling for a very nose-high attitude during landing. In the HL-10 the nose-up angle is 25 degrees; in the M-2 it is 15 degrees. Basic flight instruments are placed in one horizontal row just in front of the pilot's knees, so that he can see the horizon over them through a transparent panel in the lower part of the nose. System indicators and controls are located on side panels and consoles.

A split warning light is to be installed above the flight instruments protruding slightly into the pilot's external field of view. Thus, the pilot's attention is directed to a trouble indication on his right hand side panels when the right hand half of the warning light goes on.

Both craft will be equipped with a lightweight, rocket-powered T-37 ejection seat made by Weber Aircraft Corp. It is capable of launching the pilot over the tail of the B-52 while the research vehicle is still mounted on its pylon. ■



Isn't this the way everybody builds airplanes?

Of course not.

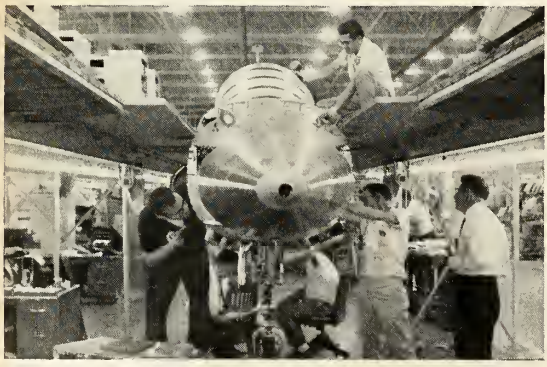
It's not practical to build large aircraft this way. And if you're making small ones you wouldn't want to invest in production lines like these unless you intend to build a lot of them.

Even then you couldn't take advantage of this "airborne" assembly technique unless you had already designed your airframe so things can be put in easily from the outside after the skin is on.

Northrop's T-38 and F-5 family of supersonic trainers and tactical fighters are designed so everything that needs maintaining is easy to get at. This means that the systems and subsystems are easy to install in the first place.

These unique production lines not only make the job easier – they make two rugged and reliable airplanes even more trouble-free by removing inconveniences that cause human beings to make mistakes.

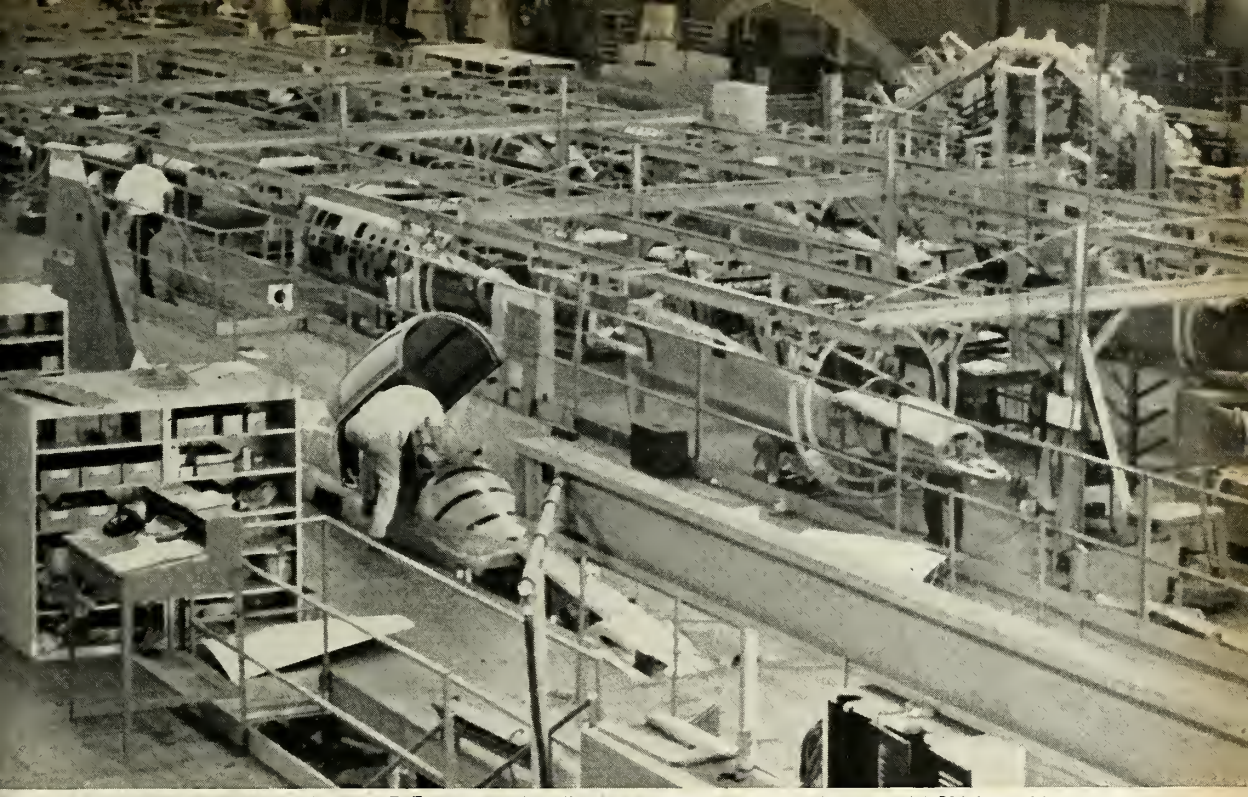
Men can work over, around and under the fuselages in natural positions without getting in each



Men work comfortably on three levels. Floor is clear.



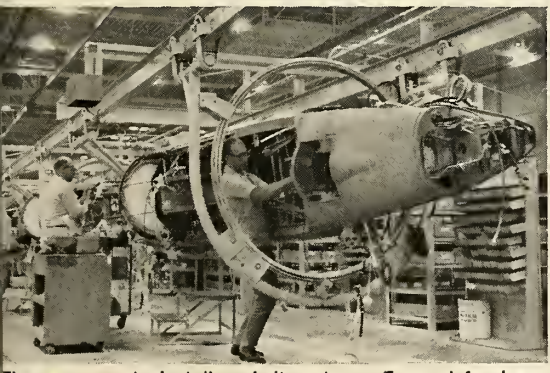
Two men move a fuselage to the next station.



At left are final assembly lines for T-38 and F-5. Forward fuselage lines are at right. Overhead-rail lines total 1,690 feet, with 50 work stations.

other's way. That's because the fuselages hang from elevated rails instead of resting on dollies. Sides of the fuselages are at natural standing height. Bottoms are far enough off the floor so men can work under them comfortably seated. The rails support platforms for work on top.

When the time comes for the lines to move, two men push each fuselage to the next station. The floor doesn't have to be cleared—it's clear anyway because all utility outlets are 7 feet off the floor in the rail structure. No clutter of cables and hoses on the floor. No dirt and junk to sweep out of tracks.



The easy way to install cockpit systems. Forward fuselages rotate 360° in trunnions.

Parts and tools are near workers on both levels. No long walks, no waits.

Before they're mated to the center fuselages the forward fuselages have overhead-rail lines of their own. Here the cockpit sections hang in trunnions so they can be turned on their sides. Instead of standing on his head to work in a cockpit, a man stands comfortably on his feet. Another, standing across from him, installs systems in the belly.

Military aircraft have become sophisticated weapons systems. Most of them are so complicated, and production runs are so short, that it's not practical to apply volume techniques.

The T-38 and F-5, however, belong to a new generation. Their design carries sophistication to its logical end: simplicity. They deliver outstanding performance, yet they're simple to fly, simple to support and maintain. And with Northrop innovations in volume production techniques, they're simple to manufacture, too.

We always wanted to build airplanes this way. Now we can.

NORTHROP



Is it fish or foul play?

Sorting out real target information from the rest of its watery environment is one of the most complex problems of antisubmarine warfare.

This year ITT was named systems manager for the new Atlantic Undersea Test and Evaluation Center (AUTEC) that will be the principal U.S. Navy facility for checking out ASW weapons systems. AUTEC will be an "inner space" range, the first capable of precision tracking in an underwater atmosphere of great distance and depth.

Soon the whole range of ASW problems—detection, classification, pinpointing and destruction—will be examined in a controlled, yet authentic, marine environment.

AUTEC will be 100 miles long, 20 miles wide and 6,000 feet deep. ITT will lace this ocean area with hydrophones and other sensitive instruments, erect tracking gear to permit thorough underwater evaluation of such advanced ASW weapons as SUBROC and ASROC.

ASW is not new to ITT. World War II's HUFF-DUFF system that pinpointed U-boat radio transmissions, no matter how brief, was an ITT development.

In 1957, after solving the problem of high density storage of multichannel analog information, ITT developed equipment to record underwater acoustical environments. Now, ITT sonar simulators using tapes of actual conditions can train up to 10 sonarmen at once.

Currently, ITT is developing DINAH, an advanced underwater detection system based on electro-magnetic principles.

International Telephone and Telegraph Corporation. World Headquarters: 320 Park Avenue, New York, New York 10022.

THESE ITT COMPANIES ARE ACTIVELY SERVING U. S. DEFENSE AND SPACE PROGRAMS: AMERICAN CABLE & RADIO CORPORATION • FEDERAL ELECTRIC CORPORATION • ITT CANNON ELECTRIC INC. • ITT COMMUNICATION SYSTEMS, INC. • ITT DATA AND INFORMATION SYSTEMS DIVISION • ITT ELECTRON TUBE DIVISION • ITT FEDERAL LABORATORIES • ITT GENERAL CONTROLS INC. • ITT GILFILLAN INC. • ITT INDUSTRIAL LABORATORIES DIVISION • ITT INDUSTRIAL PRODUCTS DIVISION • ITT INTELCOM INC. • ITT KELLOGG COMMUNICATIONS SYSTEMS • ITT SEMI-CONDUCTORS, INC. • ITT SURPRENANT INC. • JENNINGS RADIO MANUFACTURING CORPORATION.

ITT

Technical Countdown

ASTRONAUTICS

Hovering Rocket Funded by DASA

Funding for the Hovering Rocket System is out of the Defense Atomic Support Agency (DASA) rather than the Army's Ballistic Research Laboratories as generally believed. The latter agency only served as the negotiating agency for DASA, which at the time the contract was placed did not have the in-house technical capability to supervise such a contract. The Naval Ordnance Test Station, China Lake, Calif., is, in effect, the prime contractor. The system will employ a two-stage rocket to place a 700-lb. payload in a stabilized hovering position in the upper atmosphere for from 30-120 seconds (at altitudes from 500,000 to 65,600 ft.). Two vehicles will be built and NOTS will develop the second-stage hovering platform in-house. The payload, reportedly to be used for "surveillance," will be recoverable.

Swami Study Circulated

A 31-man team of Stanford University students has just completed a "proposal" for a $40-million-a-year global satellite weather prediction system that could save the U.S. alone as much as $6 billion annually. Although the "proposal" is in fact the result of a six-month classroom project, a detailed report on the system will be sent to the Meteorological Office, NASA, DOD and other interested agencies—but not, of course, in the form of a proposal. The Stanford system, called *SWAMI* for Stanford Worldwide Acqisition of Meteorological Information, would utilize three 400-lb. satellites in 1,200-mile circular polar orbits and 120 degrees apart. These satellites would receive meteorological data from a global network of weather balloons, floating freely at constant altitudes of 18,000 and 50,000 feet, and free-floating and anchored buoy stations. On command, the satellites would transmit the stored information to a single tracking station (the *TIROS* station at Fairbanks, Alaska, is put forward as an example) after each two-hour orbit.

ELECTRONICS

Solution of SF6 Problem Offered

A technical basis has been laid for reducing the enormous costs caused by sulfur hexafluoride (SF6) leaking from high-power microwave systems, say officials at Rome Air Development Center, and "could save (the government) several million dollars a year." The method involves diluting SF6 with nitrogen to yield a less expensive mixture—the insulating characteristics of which are essentially unchanged at microwave frequencies. This development is also expected "(to) prove valuable in development efforts of nanosecond multi-megawatt microwave spark gap switches opening new vistas for improving power handling capability and recovery time of these type switches."

Short-pulse Linac for Weapons Studies

To develop extremely-short gamma-radiation pulses for AEC weapons-systems studies, Edgerton, Germeshausen and Grier Inc., Santa Barbara, Calif., is planning to modify its recently installed linear accelerator to get one-nanosecond pulses. At present, the instrument produces more than 10^6 Roentgens in 10-nanosecond pulses. Made by the ARCO division of High Voltage Engineering Corp., the Linac has delivered a beam current of two amps at 10 nanosecs., with 15.5-Mev peak energy. Pulses 4.5 microsec. long with a beam current of 1 amp have also been delivered. To get nanosecond pulses of electrons, an electron gun with a semi-coaxial structure is being designed with funds from Lawrence Radiation Laboratory. To inject the short pulse into the machine in synchronism with the 1.3-kmc acceleration signal, maximum time jitter must not exceed 0.1 nanosec.

OPTICS

Large Lens Evaluation Technique Perfected

Interference patterns are used to determine the difference in the optical path of rays emerging from the various annular zones of large lenses in a pair of techniques developed by F. E. Washer and W. R. Darling of the National Bureau of Standards, Institute for Basic Standards. The sum of these differences is then converted to a wavelength unit whose magnitude is a measure of lens performance. Lenses of any size can be evaluated by either of the techniques evolving from the study. In the NBS method, two parallel vertical slits, separated by a small fixed distance, are placed between lenses under test and a viewing instrument so that the lens-induced phase changes in the emergent rays form an interference pattern in the instrument's image plane. Measurements of the interference fringes produced by various annular zones of the lenses permit the calculation of the total optical path difference. The two techniques are methods of obtaining the interference patterns.

ADVANCED MATERIALS

New Electron Crystal Structure Theory Advanced

A theory that may accelerate the development of materials for nuclear and space applications was detailed by its author, Dr. Leo Brewer of the University of California, (Berkeley) at last week's International Materials Symposium. Brewer, director of the Inorganic materials division of the University's Lawrence Radiation Lab, suggests his "Electron Theory of Crystal Structure" offers a systematic guide to the chemical manipulation of the more important transition metals. Brewer's theory makes possible a complete description of the behavior of 33 metallic elements when mixed in various combinations and subjected to a variety of temperatures. In developing the theory, Brewer combined the early work of Niels Engel with information on the sizes of atoms with predictions of solubility theories, together with knowledge of the effects of heat on various combinations and ratios of the metals. The theory is said to indicate how to enhance superconducting properties, how to strengthen lightweight materials and how to remove transistor material impurities. It also predicts that compounds can be made that violate earlier chemical laws pertaining to definite combining proportions.

Oxygen Atoms Increase Oxidation

The high temperature oxidation rates of molybdenum and tungsten are drastically increased in the presence of oxygen atoms. Experiments by Dr. Daniel E. Rosner and H. D. Allendorf at the Aero Chem Research Labs subsidiary of Pfaudler Permutit Co., reveal the neutral O-atoms to be up to 400 times more efficient than O_2 in oxidizing molybdenum. Details of the experiments have been published on pages 3441 and 3442, J. Chem. Phys. *40*, 1 June 1964. The work was sponsored by the Air Force Office of Scientific Research. Results emphasize the need to consider possible dominant effects of dissociation in the design of refractory metal structures for high-temperature, low-pressure operations.

Army To Use Computers to Simulate Radio Frequency Interference Problems

EETF will use mathematical models in effort to assure electromagnetic compatibility in tactical equipment

by Charles D. LaFond

FT. HUACHUCA, ARIZ.—Emphasis has been shifted during the past year from field tests to highly complex computer simulations at the U.S. Army's Electromagnetic Environmental Test Facility (EETF) here.

The change, said Army Electronic Proving Ground officials, resulted first from a limitation in funds for expansion of the field facility and then from a growing confidence in the practicality of the mathematical models evolved during the past four years of the program.

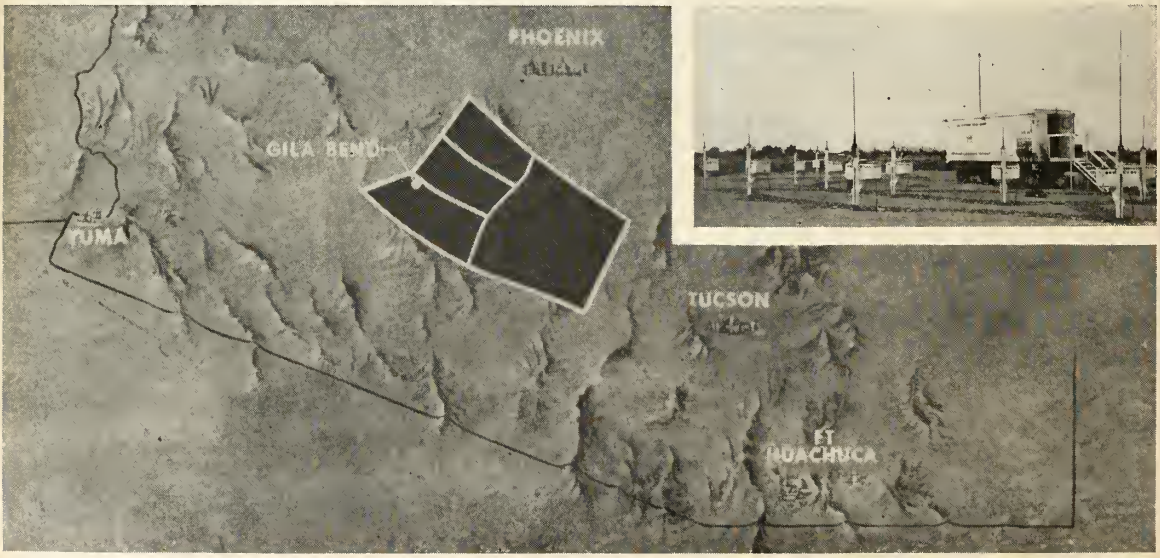
In 1960, the Army together with the EETF/Drone Test Range prime contractor, Pan American World Airways, launched a broad frontal attack on the steadily worsening problems of radio-frequency interference. Through the use of laboratory tests and measurements, field tests, and computer simulations, it was planned to progress in orderly steps from the typical number and variety of RF emitters encountered at the platoon level up through that of an opposed field army (up to 150,000 emitters) in any geographic location, using all expected types of communications and electronic equipment.

Field facility funding, however, was cut off at Phase 3—400 emitters representing all the communications equipment of an army corps in isolation.

The Army claims that the original goal will be achieved, despite the limitation in funding, through the use of interference-model evaluations supported by workshop and field validation and evaluation. The program now includes human engineering and later will include aspects of maintenance and training.

● **Contract situation**—On March 15, 1960, Pan Am was awarded a two-year contract from the Army for roughly $21 million to operate the Drone Test Range between Ft. Huachuca and Yuma, Ariz., and to establish

THE ARMY'S Field Test Area for the Electromagnetic Environmental Test Facility near Gila Bend, Ariz., is shown in dark area. Inset is a typical electromagnetic environment generator van and RF emitter installation.



and operate an Electromagnetic Environmental Test Facility in the Ft. Huachuca reservation. Subsequently, a three-year extension was given to the firm, carrying the program up to March 15, 1965.

Total contract value is $50.7 million for the 5-year period. Roughly half this sum is for the EETF.

Principal subcontractor to Pan Am is Bell Aerosystems Co., a division of Bell Aerospace Corp., which has performed the bulk of the engineering effort in the EETF program. Total funding to Bell for the 5-year period is about $21 million.

● **EETF goals**—The Army Electronic Proving Ground here was given the responsibility early in 1960 of initiating a program to investigate RF interference problems associated with tactically deployed units. The field facility itself was located near Gila Bend in an area covering about 2,400 sq. mi. of desert land.

Through worst-case experimental operation with standard and new developmental field emitters, the facility has provided a means for detecting the presence of RF interference, determining the resulting operational degradation, isolating interference sources, and recommending corrective measures to reduce the effects of interference.

A goal sought through the EETF is the development of design specifications and operating techniques that will assure reasonable electromagnetic compatibility of all future field equipment.

● **Present approach**—While heavy emphasis is being placed today on the use of interference model evaluation, the model must be supported by field and instrumentation workshop validation.

The test process starts with the collection of spectrum signatures of the equipment at either AEPG or the White Sands Missile Range.

Next, the emitter is checked out under laboratory conditions to minimize variables and establish an operating standard. Following shop validation, the equipment is moved out to the field test facility.

The equipment is modified only to permit automatic operating control and performance monitoring. It is deployed, along with many other emitters in a manner realistically representing a tactical situation. Individual emitters are located radially about 24 electromagnetic environment generator vans (EGV).

Each van is connected to a forward test site (FTS), which is capable of on-off cycling (30 seconds) all the environmental generators in any combination or sequence automatically. A rear test site (RTS) is connected to the FTS, and both sites may have their own local emitters situated radially about them. The control function of the entire facility is centralized at the FTS. Control sequencing is determined by a punch-card programmer.

Scattered throughout the area are a number of mobile environmental analysis vans capable of RF reception, direction finding, field-strength measuring and recording.

● **Model evaluation**—Data obtained in the shop and field tests, propagation data, and a multitude of other variables can be fed into the AEPG computers for evaluation. By varying geographic areas (using different X, Y, Z deployment coordinates and terrain constraints), problems have been run successfully for Arizona, Germany. and Cambodia.

Spectrum signatures, physical constants, varying numbers of emitters operated simultaneously, frequency assignments, acceptable operating levels—all can be fed into the computers to provide an infinite number of different problems. Thus, by using only a relatively small number of equipments in the field, the computer simulations tend to reduce the time and extent of test processes.

Current estimate for the evaluation of a typical deployed division is about 30 hours using IBM 709's. Soon IBM 7090's will replace the slower computers and greatly increase the computer capability, Army officials said.

● **Current tests**—Using a 500-meter grid matrix at the field facility, fourteen tactical field tests have been performed to date. This represents an evaluation, said one Pan Am engineer, of about 40 radio nets operating under 14 frequency assignments.

In compatibility tests, variations of the use of field testing and model simulations have been worked out to improve evaluations. Recently, short-range electronic positioning equipment, a long-range survey system, and the new 920-channel FM vehicular radio set (AN/VRC-12) have been through compatibility tests.

Current system tests include a new single-side-band FM manpack, AN/PRC-38; the FM manpack, AN/PRC-25; and the helmet radio AN/PRT-4 and /PRR-9. A parallel effort for making battlefield electromagnetic radiation calculations also is underway. This involves the prediction of field intensities over deployed areas of fixed sizes and includes the emitters of opposed divisions up through opposed field armies. The use and effects of electronic countermeasures is included in the simulations.

● **Future needs**—There still remains room for considerable improvement in the test and evaluation program, pointed out Col. J. L. Burke, director of the USAEPG Test Programs and Evaluations Dept.

Validation must be made all across the frequency spectrum, he stated, and interference model improvements are needed for equipment growth areas.

For the future, he said, study areas will include:

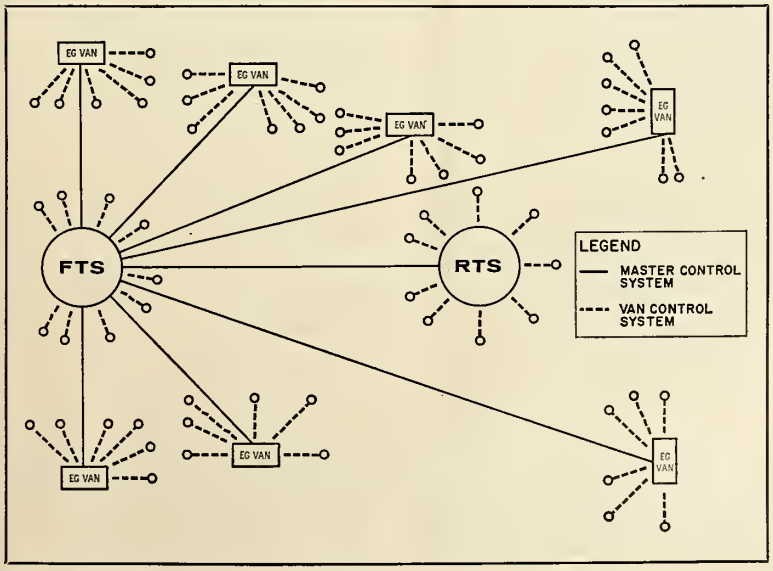
—Missile system RF hazards.

—Application of electromagnetic radiation field tests to equipment vulnerability and suceptability.

—ELINT problems.

—A greater emphasis on vehicular effects on spectrum signatures and the cumulative effects of massed vehicular operation. ■

DIAGRAM shows relation of electromagnetic vans and emitter installations to forward and rear test sites in field test area.



MSC Begins Testing Reliability Of Water-Cooled Apollo Space Suit

by Warren Burkett

HOUSTON—Manned Spacecraft Center Engineers—encouraged by early tests of a water-cooled space suit for Project *Apollo*—are now launching an R&D program to prove its reliability.

The suit employs plastic tubing—sewn into long underwear—which carries water to remove metabolic heat generated by astronauts.

Its development was begun by the Royal Aircraft Establishment (RAE) in 1962. MSC work on the suit started in 1963 when Dr. John Billingham left RAE to join the center staff as its head of environmental biology.

A parallel research program was also begun at Hamilton-Standard Div., United Aircraft Corp., prime contractor for the *Apollo* spacesuit.

Early results of the tests—which Dr. Billingham believes indicate that water cooling may be a more simple and reliable method of cooling than the air-cooled suits used in Projects *Mercury* and *Gemini*—include:

1) Skin temperature of test subjects remains about 82° during hours-long treadmill workouts; subjects wearing suits cooled by oxygen flow register 97°.

2) Subjects remain dry in the water-cooled suits because cooling is achieved by conduction of heat to the chilled piping instead of evaporation of perspiration from the man's body.

3) Less stress is put on the heart and circulation system, and the dangers of dehydration are reduced because the man's own heat-regulation system is not taxed to remove all the heat load through perspiration.

4) By the way the coils of plastic tubing are sewn into the garment, a more normal pattern of human heat regulation can be achieved, with the arms and feet being cooler than the abdomen, thighs, and chest.

5) Less energy is needed to pump the water through the suit than to maintain the required flow of chilled oxygen used in evaporative cooling.

Gil Freedman, MSC engineer on the team with Dr. Billingham, and physiologist James Waligora, estimated that roughly 15% of the weight of the *Apollo* suit's back pack could be eliminated by switching to water cooling. The prototype battery and pump mechanism weighs less than a pound. Weight of the cooling garment, tubes, and water manifolds at the inlet and outlet areas is slightly more than two pounds.

● **Construction**—The tubing network was constructed of ⅛-in. polyvinyl chloride tubing; 40 six-foot lengths of the tubing were used. Cooling the water results when the liquid is pumped into a reduced pressure chamber where it flashes to a vapor. The water enters the suit at 55°F and heats up about 11°, said Dr. Billingham. Cooling capacity of the unit has been rated at about 2,000 Btu/hr. with flow rates of 150-300 lbs./hr. of water.

In a demonstration at MSC, the British pitted their prototype suit against the standard cooling-by-evaporation technique used in American space suits. The test subject was placed in a heat chamber adjusted to the thermal environment expected on the Moon.

After 45 minutes of measured work, the conventionally attired subject was sweating at a rate of more than a pound an hour, was feeling very hot, and said he could not carry on at that work rate any longer.

In the second part of the demonstration, the water-cooled undergarment was activated. The rate of sweating dropped, and the subject could be made cold at will, said Burton in *RAE Technical Report Mechanical Engineering No. 400.*

● **Mail-order space suits**—After observing the English suit, MSC researchers purchased a suit of long underwear from a local mail-order store and 240 ft. of plastic tubing. Instead of threading the tubing through holes in the underwear, the MSC engineers sewed the tubes to the cloth in a pattern designed to deliver the chilled water to areas in a manner proportional to the normal body temperatures.

The home-made thermal suit was tested for more than a year, and a factory-made model was delivered late in May by Hamilton-Standard.

Burton, in his report, said several models of the British suit were being prepared for testing in the United Kingdom and elsewhere. Burton said the Royal Australian Air Force at the sweltering base near Darwin was interested in the suits for standby and possible use by Mirage 3 aircraft crewmen.

Canadians, said Burton, are also interested in possible applications of the suit for divers operating in extremely cold water. By replacing the cooling mechanism with a heater, the suit can warm the body.

Freedman of MSC said tests had been considered using a mixture of water and glycol to insure that the heat-transfer medium would not freeze under extremely cold conditions. Burton's team subjected test subjects to immersion in freezing water and found that the men reported feeling warm and comfortable throughout the experience.

● **Suit termed promising**—Dr. Billingham said the water-cooled suit now was "at the hardware stage," but "looks promising for the future."

"It is now in research and development. In operation and in theory the suit looks acceptable. But we must test it much more for reliability."

Engineers at MSC have been successful at keeping leaks from the tubing at a minimum. The suit uses only about half a gallon of water and poses no danger to the wearer. In case of a major leak inside the space suit, a reserve tank of water would insure cooling until the lunar astronaut could return to the Lunar Excursion Module to change.

Burton pointed out that humans always exude some moisture through their skins or from their lungs. Without a flow of air, this water will accumulate in the space suit. However, he indicated that test results showed the flow of oxygen for breathing may be sufficient to evaporate this condensed moisture. ■

Combustible Rocket Cases Developed For Shillelagh, Other Programs

by William Beller

A COMBUSTIBLE rocket case for the boost phase of the *Shillelagh* antitank and field fortification missile is going into pilot production.

This marks the first time a combustible case has gone out of the laboratory stage for a major missile system, say engineers at Atlantic Research Corp., contractor to Picatinny Arsenal where the *Shillelagh* case is being developed. Philco's Aeronutronic Division is developing the *Shillelagh* weapon system.

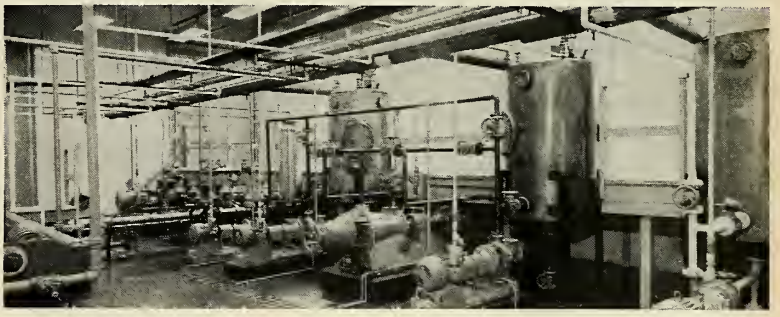
The concept of the combustible case stems from over a decade of Army work at Picatinny Arsenal, which several years ago led to combustible cases for ordnance ammunition for the 105-mm howitzer and 105-mm gun. Not only are the rounds with combustible cases lighter and cheaper than conventional rounds, but also they leave no empty brass to clutter up tanks or to be hauled back to depots.

These advantages figured in the choice of a combustible case to house the propellant needed to thrust the *Shillelagh* out of its gun. After the missile leaves the gun, the main rocket takes over.

● **Safety factor**—Beyond the *Shillelagh*, Atlantic Research is looking to combustible cases for meteorological and other type sounding rockets launched over populated areas. The worrisome problem here is how to destroy the rocket nozzle as well. Robert Sherwood, head of ARC's process engineering section, says the answer is the frangible nozzle. He also suggests making satellite structures of combustible-case material. Thus, when spacecraft have outlived their usefulness, they can be destroyed.

Other organizations are also looking into both combustible and consumable cases for similar applications. A combustible case is one whose destruction is self-sustaining because of the oxidizer and fuel built into it. The consumable case, on the other hand, is destroyed by the propellant it surrounds.

Among these organizations are Hercules Powder, which is making a case involving fibrous threads and a special winding technique for meteorological rockets; Thiokol; and IIT Research Foundation of the Illinois Institute of Technology, which did some of the fundamental work on developing combustible-case theory.



PART OF pilot production plant for manufacturing combustible Shillelagh cases at Atlantic Research Corp.'s Pine Ridge Plant, Gainesville, Va. View of automatic stock-refining system for the slurry shows vertical stock tanks in the background, pumps in foreground, Jordan Refiner in the center, and vacuum and metering systems at far left.

Because the combustible case is relatively weak, it is considered only for medium- to small-sized rockets. The *Shillelagh* case, for instance, is only about 151 mm in diameter.

● **How it's done**—The ARC manufacturing process is one of felting, a method updated by IIT, but based on the ancient method of making paper. Any fiber, sisal, leather product, sawdust, hair, or glass fiber can be felted. In general, a slurry is made of water and the fibers. The water is then removed by a vacuum, which leaves a "felt" of interlocking fibers on a screen or porous mold.

Although the formulation for the *Shillelagh* combustible case is classified, a possible mix might be sawdust, kraft paper and magnesium staples. These ingredients would then be felted with an oxidizer and a resinous binder. Except for loading the stock materials and removing the final *Shillelagh* cases, the ARC pilot production plant is designed to be fully automatic.

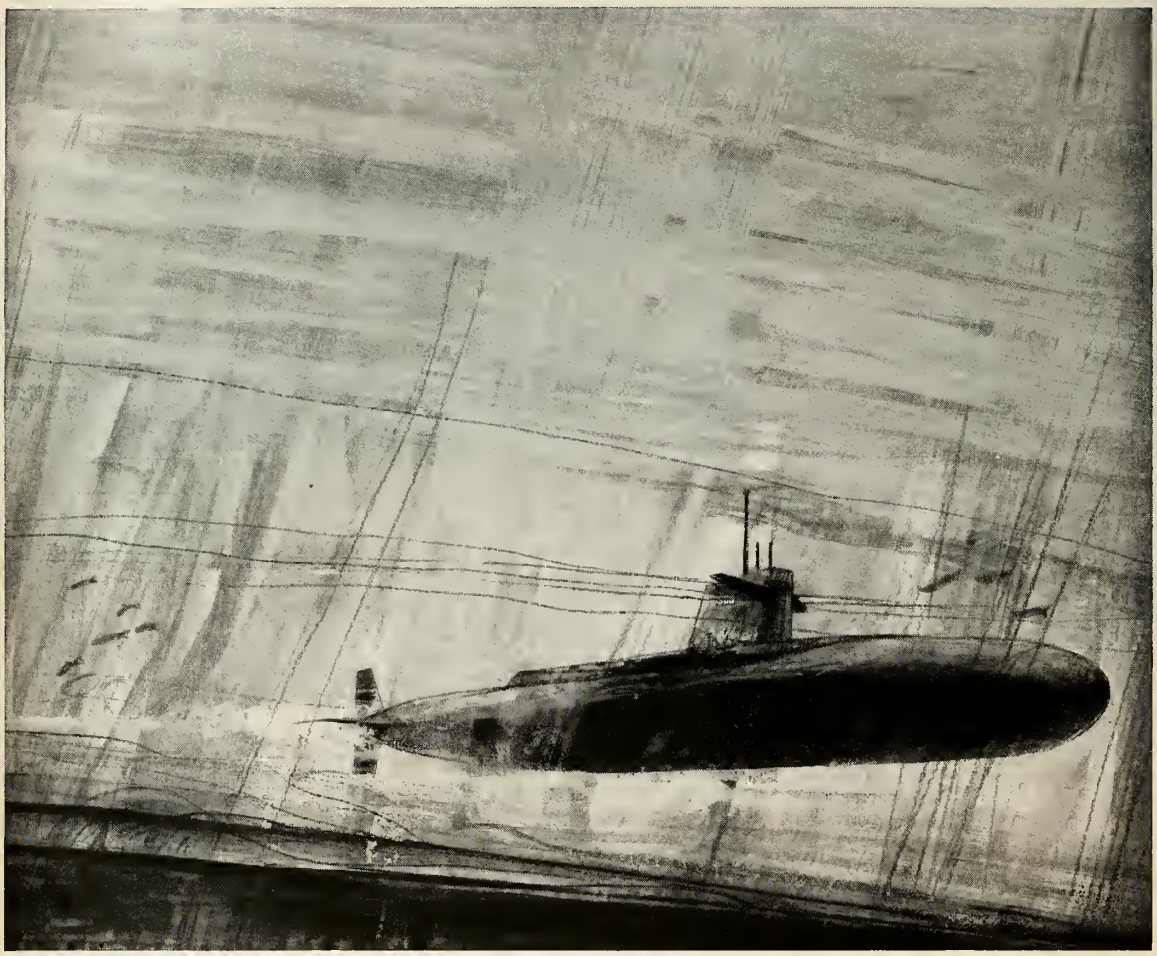
A typical combustible case weighs about 0.35 gm/cm^3 as compared with the usual 2.7 gm/cm^3 aluminum sounding rocket case. Sherwood says the manufacturing process is also "substantially" cheaper.

To get the felting process on a production basis, ARC feeds its slurry into a closed mold. A vacuum is then drawn on an annulus around the mold, the water is exhausted, the case is pressed on the mold to expel excess moisture, and then the case is ejected.

One of the basic problems still facing combustible-case manufacturers is to achieve a satisfactory compromise between the high porosity needed to get the most combustible case and the low porosity needed for overall strength. ARC spokesmen claim to have developed a formulation that "is a pretty good answer."

Looking for further applications for combustible cases, ARC sees them used in 20-mm rounds in aircraft. If this idea works out, there will be no further need for bothersome ammunition-feed cases. ARC sees a further use of its cases in a limited war situation since anti-personnel chemicals such as paralytic agents can be incorporated in the missile case formulation and dispersed over targets —thereby yielding a weapon with a dual-purpose warhead. ■

Is this what most engineers mean when they say RELIABILITY?



An integrated inertial navigation system that can guide a nuclear-powered submarine for weeks in the ocean depths without surfacing.

That is reliability. The system is called the Mark II SINS. It was designed, developed, and produced by the Autonetics Division of North American Aviation. Today it guides the Free World's nuclear-powered, Polaris-carrying submarines, accurately giving them their position and velocity plus the direction of north at all times. It is but one of many achievements pioneered by the engineers and scientists at Autonetics in the area of integrated systems application with built-in cost effectiveness. These achievements by Autonetics have now set a new standard of reliability for the entire electronics industry.

North American Aviation/Autonetics

Next Soviet Manned Shot Believed One Year Away

Part II of COSPAR report includes contributions of British, French, Italian and other space programs

by Frank G. McGuire

FLORENCE, ITALY—The Soviet Union probably will not undertake another manned space flight for at least a year —at about the same time the first U.S. manned *Gemini* flight is expected to take place—but the Russian launch is likely to be an attempt at orbital rendezvous.

This estimate is made on the basis of reports circulating at the recent meeting here of the Committee on Space Research (COSPAR). The slack in the schedule of manned spaceflight missions was attributed to the now-realized need for more thorough research into human reactions and hardware reliability during extended-duration flights.

Manned *Gemini* flights are still officially slated for late this year or early in 1965, but sources at the COSPAR sessions expressed doubt that a manned *Gemini* will be off the ground before late next spring.

A number of experts from both Russia and the United States said that it was beginning to appear that spaceflight utilizing currently available equipment would be limited to about five days' duration. To go much beyond that period would, they declared, require the adoption of new design approaches. They pointed to biomedical findings reported earlier (M/R, May 25, p. 44).

● **Other voices**—Apart from the U.S. and Russia, many scientifically important programs, some small and some large, were unveiled at the COSPAR meeting.

Understandably, the major contributions came in reports from Western Europe—Great Britain and France in particular. International programs often formed a thread of continuity, although the French exhibited a strong tendency toward strict national independence in their programs.

France expects shortly to launch its own satellite with a home-grown launcher; Italy, by contrast, is preparing its San Marco project for orbiting a satellite with a U.S. booster from a floating platform.

● **Britain**—One unexpected research finding in the British report is the Royal Aircraft Establishment's discovery that the rotational speed of the Earth's atmosphere is greater than that of Earth itself. D. G. King-Hele found through observations of a number of satellites that the atmosphere at altitudes from 200-300 km rotates from 1.1 to 1.9 times as fast as the Earth's surface. No apparent reason was given for the phenomenon, detected through observations of nine satellites orbiting during 1958-63 from 0° to 60° latitude.

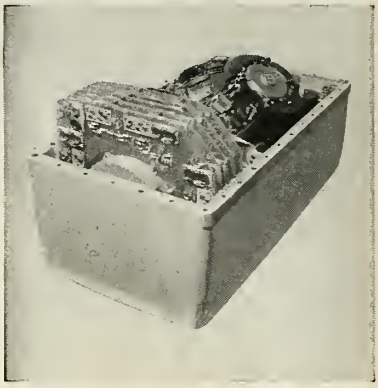
"If the angular velocity of the atmosphere is expressed as A times the angular velocity of the Earth, the values of A obtained all exceed 1, ranging between 1.1 and 1.9, with a mean of 1.46 and r.m.s. scatter of 0.28," King-Hele's paper said. It added that, for an eastbound satellite, the orbital inclination can decrease as much as 0.1° due to the rotational effect of the atmosphere at or near the satellite's perigee.

In large measure, the space science program of the United Kingdom is keyed to preparation of experiments for inclusion on payloads to be launched by the European Space Research Organization (ESRO), or by NASA.

Continuation of a number of cooperative U.S./U.K. arrangements was noted in the British report, which mentioned that, in addition to the satellite payloads being orbited for the British by NASA, experiments by British scientists will be included on *OSO-D, OSO-E* and *OAO-C*. In the *OSO-D* payload will be a grating monochromator to determine accurately the quiet sun component of the solar He II resonance emission (303.8 Å) flux, as well as short-term increases due to localized solar activity.

Another British experiment aboard

And is this what most engineers mean when they say APPLIED MICROELECTRONICS?



It is called the N16 Autonavigator.

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34 Circle No. 8 on Subscriber Service Card

OSO-D will be the study of soft solar X-ray emissions from 1.2 to 18 Å and from 44 to 70 Å. British scientists hope to separate thermal from non-thermal processes and to study the development of solar flares during the quiet period.

OSO-E will have a grazing incidence reflector and a defining slit in conjunction with proportional counters to study discrete sources of X-rays. This would permit differentiation of thermal and non-thermal processes of the disc and corona, as well as estimation of various temperatures.

Launching of experimental payloads by *Skylark* rockets has proceeded at a steady pace, said the British report, with a new attitude-stabilized payload head now entering service to give a new area of utility to the vehicle. *Skylark* is still the principal British research vehicle. Other scientific payloads are launched aboard *Black Knight* rockets from Woomera for ionosphere or cosmic radiation studies, which require greater altitude than *Skylark* can attain. A 5-in. solid-fuel rocket for meteorological purposes has been put into service, and reaches altitudes of 50-60 km. It is being used at small ranges for determination of wind velocities and temperatures.

● **France**—In addition to solar research and balloon-borne experiments, the French effort features a program of sounding rocket firings using *Centaure, Bélier, Véronique, Emma,* and *Dragon* vehicles. Thirty-six launchings using these rockets were carried out in the past year, achieving altitudes up to 420 km with a *Dragon* vehicle, although *Véronique* and *Centaure* were the more frequently used. The latter two generally reach from 125 to 175 km.

Three new launching vehicles are now undergoing flight tests, one solid-propellant and two liquid versions. *Véronique* 61, a single-stage vehicle using nitric acid and oil of turpentine, will take a 220-lb. payload to altitudes of 350 km. *Vesta,* another single-stage vehicle using the same liquid propellants, will boost between 440 and 2,200 lbs. to altitudes as high as 500 km. *Rubis* is a two-stage solid-propellant vehicle designed to carry a 110-lb. payload to altitudes around 2,000 km. All three new vehicles are now being tested and are expected to be operational soon.

In addition to the *FR-1* satellite, due for a NASA *Scout* launching from Pacific Missile Range, France is preparing its own orbital payload, *D-1,* for launching aboard a *Diamant* rocket from Hammaguir. *D-1* will be placed into an elliptical orbit of 600 to 2,800 km at an inclination of 30° and a period of about two hours. Life expectancy is approximately three months.

The *D-1* is a cylinder of about 19.7 in. diameter and 7.9 in. length. It will be essentially a test payload carrying telemetry equipment operating on 136, 150, and 400 mc. Power will be from 2,304 solar cells.

● **Italy**—A key Italian program is the San Marco Project, intended to launch a satellite from an equatorial floating launch pad for studies of atmospheric characteristics. A complete mobile range is under development, based on the offshore drilling rig approach; first firings will use a *Scout* booster with an Italian-designed-and-built payload. Aerospace Research Center of the University of Rome is handling the program, with Prof. L. Broglio as Director.

Specific parameters to be measured are atmospheric density, molecular temperature, electron content and radio propagation.

Firings of sounding rockets from the San Marco range, off the coast of Kenya, are checking out prospective satellite instrumentation as well as the range operation. The launching platform is a triangular steel hull 120 ft. long with three legs extended to the sea bottom. Electric motors raise or lower the legs for height adjustment.

For launch operations the legs are extended to the bottom so that a stable platform exists, while raising the legs drops the platform to the water, where it floats and is towed to another launch site by tugboat. Six months' complete self-containment is supplied to the platform by logistics bases. The platform itself is referred to as the Santa Rita launching platform.

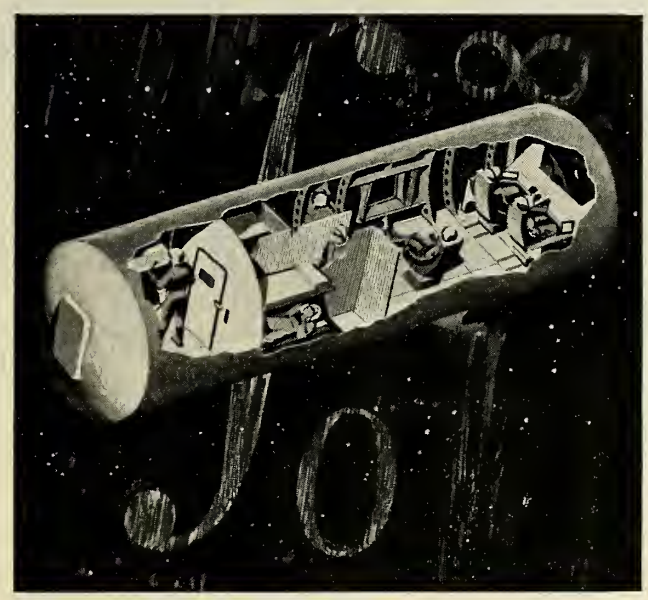
In addition to the launch platform, the San Marco range includes a control ship and support ship. These are now in the Indian Ocean, while the Santa Rita platform is in Kenya's Formosa Bay. Submarine cables connect the control ship with the Santa Rita platform, and all operations are carried out with no personnel aboard the platform. The control ship, M/n Pegasus, conducts all activities automatically. First firing of a sounding rocket with the satellite's electronics was conducted March 25.

● **Worldwide efforts**—Well over 25 reports on many national sounding rocket, balloon, and ground-based scientific studies were presented to the COSPAR meeting. Most rocket-borne experiments used space made available on British, French or U.S. vehicles at established ranges; others employed loaned rockets launched from newly set-up ranges. The latter approach was typical of Norway, Sweden and India, for example, while Germany and Britain borrowed space on French rockets and a number of countries had experiments on U.S. rockets.

● **Further U.S. reports.**—U.S. papers covered myriad new experiments.

(*continued on page 36*)

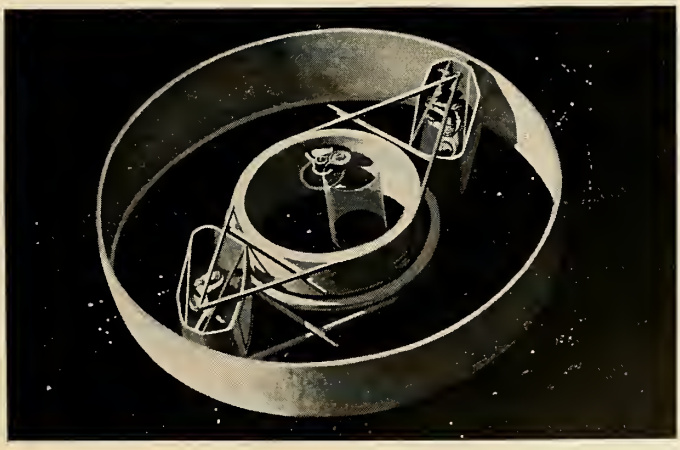
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U.S. scientists this year are expected to devote a greater amount of attention to gamma radiation sources in an effort to pin down the number and location of such sources in the sky. Some experimenters have found discrete gamma ray sources, while others have found no such evidence. The report did not say exactly which rockets and satellites would be equipped with instrumentation for this work.

● **Galactic collapse?**—The possibility that a galactic mass of matter is collapsing at extreme distances from our own is being followed up by U.S. scientists on the theory that such an event could be "a rather spectacular source for all kinds of radiation, including high-energy X-rays and gamma rays."

A re-examination is currently going on in an effort to refine the knowledge of what happens when collisions occur in thickly-congested multiple star systems. The particular distant point of interest under observation may be undergoing an accelerated collapse with a total energy release at rates up to 10^{15} ergs per second, the U.S. report stated. Barring such an event's occurrence, other possible sources of the radiation are being investigated.

● **IMP results**—Confirmation of the pinwheel of the interplanetary magnetic field has been tentatively given by *IMP* data. Rapid rotation of the Sun, combined with the outward motion of masses of highly conductive plasma, is thought to be the cause. *IMP* also indicated the definite existence of a collisionless magnetohydrodynamic shock wave caused by interaction of the magnetosphere with the solar wind. An area of turbulence separates this shock wave from the magnetopause and both of these flare away from the Earth at an angle of 15 to 20 degrees in the anti-solar direction.

Three successive samplings of low-energy protons have been found to be consistent in time with the rotation of the Sun, as well as correlating with gradual decreases in galactic cosmic-ray intensity, terrestrial magnetic storms and the position of high-temperature coronal regions of the Sun.

"A coordinated attack on problems of the upper atmosphere and ionosphere using rockets and satellites has been going on since the IGY and has been accelerated recently under stimulus of the IQSY," the U.S. report stated.

An example of triple-cross-checking data was the firing of sounding rockets for investigating the ionosphere simultaneously with an overhead pass of the *Alouette* satellite carrying the same type of experiments. Data gathered by these two methods were then cross checked with data gained by an incoherent back-scatter method with a 440 mc radar transmitter. Consistent results by all three methods gave scientists increased confidence in each approach.

In other sounding rocket experiments involving meteorologic experiments, it has been found that the annual cycle of winds features the characteristic during spring and fall of reversing direction with great rapidity. At the 28-mi.-altitude level it was found that strong westerly winds were completely replaced by equally strong easterlies within a few days over North America. In tests over the Ascension Islands, it was found that semiannual wind-shear lines moved downward at the rate of 1.25 mi. weekly in the level between 18 to 31 mi. altitude.

Continuing success with the *Tiros* program was reported, including the fact that about 80,000 usable cloud-cover photographs were received during 1963, bringing the program total to about 250,000 since June, 1962. The photos helped spot at least five hurricanes and typhoons in incipient form during the year, and helped keep track of many others. Noteworthy was the addition of the Automatic Picture Transmission (APT) system to the satellites so that local weather bureaus possessing a low-cost receiving station could request their own area situation from the satellite as it passes.

● **Mars & exobiology**—New data concerning the Martian atmosphere was reported by the U.S., data "which are at marked variance with previously accepted concepts." Doppler-shifted water vapor lines were detected, new values for CO_2 concentration established, and a new upper limit for oxygen content calculated, all by the Mt. Wilson observatory. The information permitted derivation of new figures for Martian surface pressure, now estimated at 25 ± 15 millibars. Precipitable water vapor, 14 ± 7 microns atm.; CO_2 content, 55 ± 20 atm.; upper limit of oxygen, 70 cm atm. Data obtained from Stratoscope II agrees well with the Mt. Wilson data, the report noted, except that it set an upper limit of about 40 microns of precipitable water.

Laboratory work on the possibilities of extraterrestrial life has been continuing, and mixtures of gases which are believed to be typical of primitive planetary atmospheres have been exposed to electrical discharges, giving a wide variety of complex molecules. Irradiation of formaldehyde has produced a large number of familiar compounds such as ribose, deoxyribose, and others. Guanine has been identified as a product of the thermal polymerization of amino acids, said the report, which throws light on the relationship between protein and nucleic acid in biochemical evolution. ■



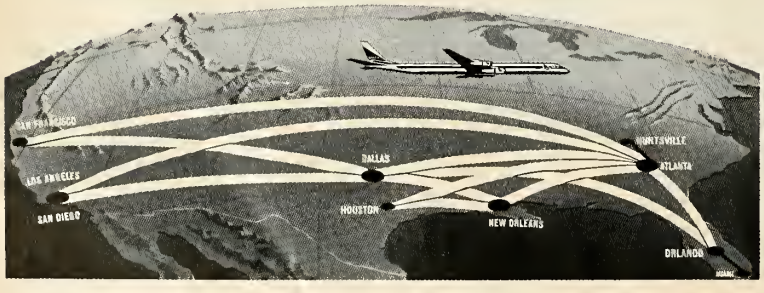
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3. **Flight Mechanics** — Experience in trajectory analysis, orbital mechanics, dynamic stability, de-orbit techniques. Physics, AE, ME, Engineering Mechanics.

4. **Systems Analysis** — To perform preliminary system optimization studies through subsystem tradeoffs. Define performance requirements and specific interface relationships between subsystems. EE, ME, Physics.

5. **Guidance & Control** — Responsible for systems analysis, synthesis, and mechanization for advanced guidance & control concepts. Requires established systems background emphasizing creative analysis and design. EE, AE, ME, Physics.

6. **Communications Systems** — Analysis and synthesis of new instrumentation and communication systems requiring analytical knowledge of communications. EE, Physics.

7. **Aerodynamics** — Configuration selection for advanced R/V's — experience in wind tunnel experiments and aerodynamic design. AE, ME, Physics, Engineering Mechanics.

8. **Analog Applications** — Develop mathematical models of physical systems; program and utilize analog techniques and computer systems for engineering problem solving. EE, Physics, Math.

9. **Command and Control Systems** — Vehicle systems design and analysis experience with emphasis on feedback control systems, guidance techniques, inertial systems, navigation, flight simulation. EE, ME, Physics.

10. **Producibility** — Participate in design to assure the most producible product through utilization of best methods consistent with specified design requirements, perform technical liaison services to in-house and vendor fabrication operations. EE, ME.

11. **Electromagnetic Physics** — Responsible for studies of radar cross sections and controls; investigation of the interaction of microwaves with R/E plasma for the purpose of predicting re-entry effects on communications and observables. Physics, EE.

12. **Optical Systems Analysis** — Responsible for optical systems optimization applied to a variety of missions for both military and planetary payloads with emphasis on reconnaissance, astronomy, and satellite tracking. ME, EE, Physics.

13. **Space Power** — Studies at systems and component levels in solar, thermionic, nuclear, fuel cells, photovoltaic, and other unconventional power sources for space vehicles. Physics, ME, EE.

14. **Fluid Mechanics** — Classical knowledge of flow fields, including depth in ablative chemistry. AE, ME, Physics, Engineering Mechanics.

15. **Materials Engineering** — Measurement and evaluation of mechanical, chemical, physical, rheological and thermo physical properties of elastomers, phenolic polymers, epoxies, and pyrolytic graphite. ChE, Physics, Chemistry.

16. **Microelectronic Materials** — Experienced in basic materials for electronics, assembly, and fabrication of microelectronic circuits and solid state devices. EE, ChE, Physics, Chemistry.

17. **Instrumentation & Communications** — Advanced training and experience in development and design of modern space communications, including information processing, logic design, electromagnetic equipment and current component part developments. EE, Physics.

18. **Electrical/Electronic Subsystems** — Analysis and design for aerospace applications. Experienced in test and checkout equipment, electronic and electrical measuring devices, arming and fuzing devices. EE, Physics.

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Company Facilities

Westinghouse Electric Corp. will install a pilot line to conduct research studies on semiconductor devices and integrated circuits at the Boeing Co.'s planned $5.8-million Aero Space Div. Facility near Seattle. Boeing will use the pilot line to conduct research and engineering studies of integrated circuits and semiconductor devices as they relate to the company's needs, and does not intend to turn out the devices in production quantities. . . . *Bell Aerosystems has put its newly constructed 21,000-sq.-ft. controlled environment facility into full operation. The new facility provides dust-free laboratories and supporting areas for the development, production and testing of inertial guidance systems and components, including accelerometers, gyros, velocity meters, platforms and optical equipment.*... Titanium Metals Corp. of America has begun construction of a new facility in West Caldwell, N.J. The installation is to serve as an application development center and as a district sales office. The development center will be devoted to investigating the properties, corrosion resistance and weldability of the metal, and will also serve as a demonstration facility for prospective titanium customers. . . . *Dearborn Electronic Laboratories, Orlando, Fla., has begun construction on a new plant to replace a building that was 80% destroyed by fire last January. Dearborn designs and manufactures capacitors, RFI filters and allied electronics devices.*... Brooks Instrument Co. has begun work on a 25% expansion of manufacturing and research facilities in Hatfield, Pa. Brooks specializes in development and manufacture of fluid flow measuring instruments.

In the Courts

The Darling Co., Bethesda, Md., developer of oxygen and oxygen/communications hose for space vehicles and aircraft, has won the first part of a suit against Space Aero Products, Inc., Rockville, Md., a competative firm founded by former Darling employees and a Darling supplier. In the suit, filed in Montgomery County Circuit Court in February, 1961, Darling charged that the former employees and the supplier had misappropriated drawings, materials and technical knowhow from Darling and used them to establish Space Aero Products. The defendents have been ordered to turn over the drawings and materials to the court for destruction and are permanently enjoined to cease manufacturing oxygen breathing and space suit hoses in direct competition with Darling. The court will proceed to hear a multi-million-dollar damage claim against Space Aero Products by the Darling Co.

Mergers and Acquisitions

Data Sensors, Inc., Gardena, Calif., has acquired the transducer line of Utah Research & Development Co. of Salt Lake City. Products acquired include absolute and gauge pressure transducers of low- and high-level output, amplifier circuitry, load cells, and force links. Data Sensors manufactures a line of proprietary pressure transducers. . . . *Polytronics Laboratories, Inc., West Caldwell, N.J., has acquired Osborne Electronics Corp. of Hawthorne, Calif. The acquisition added to Polytronics a line of transistorized communication equipment.*... Phelps Dodge Electronic Products Corp. has purchased Mectron, Inc., of Roselle, N.J., and its affiliated companies. Communications Products Co., a wholly owned Phelps Dodge subsidiary, will absorb Mectron into its Marlboro, N.J. plant. Mectron produces rigid line and rigid line accessories, coaxial connectors, dehydration and pressurization units for rigid line, coaxial cable and waveguide. . . . *Hercules Powder Co. and MHD Research, Inc., boards of directors have approved the acquisition of MHD by Hercules. MHD, Newport Beach, Calif., sells a line of magnetohydrodynamics equipment and performs research and development. It will remain in Newport Beach and will be operated as a Hercules subsidiary.*

New Activities

AGAC-Derritron has been formed in Alexandria, Va., to produce, sell and service electromagnetic vibrators. The joint company is owned by Aero Geo Astro Corp. of Alexandria and the Derritron Group of England. It will offer in the U.S. vibrators with capabilities varying from 2½ lbs. to 2,000 lbs. thrust. . . . *The Herring Corp., Van Nuys, Calif., has been renamed Vacuum/Atmospheres Corp. to more accurately reflect the firm's activities in the manufacture of vacuum systems, glove boxes and gas purification units.*

Martin Cites Three

The Martin Co. recently honored three employees for contributions to space sciences and technology. Dr. Henry G. Hermes, a basic mathematician, and George W. Haynes, a theoretical aerodynamicist, were selected "Authors of the Year" for their paper, "On the Nonlinear Control Problem with Control Appearing Linearly," published in the Society for Industrial and Applied Mathematics' *Journal on Control.* Alan J. Streb, Technical Director for Martin Co.'s SNAP systems, was selected from among 450 Martin inventors as "Inventor of the Year."

Company Representatives

Monitor Products Co., Inc., Pasadena, Calif., has appointed two sales representatives to handle its line of precision frequency control devices. Luebbe Sales Co., Cincinnati, will cover Indiana, Ohio, Western Pennsylvania and Kentucky. Dave Hausten Co., Wheaton, Ill., will be responsible for Wisconsin and Minnesota. . . .*Telonic Engineering Co., Laguna Beach, Calif., electronics firm has named George Gostenhofer and Assoc., Waltham, Mass., as sales representative in New England.*

contracts and procurements

AWARDS

AIR FORCE

$10,000,000—**Lear Siegler Service, Inc.,** Santa Monica, Calif., for aerospace and aircraft system maintenance.

$4,600,000—**Collins Radio Co.,** Dallas, for follow-on work to be done on high-frequency antennas for *Minuteman* ICBM missile sites.

$1,100,000—**Northrop Corp.,** Nortronics Div., Norwood, Mass., for follow-on production of auxiliary gyroscopes to be used in the *Minuteman* ICBM program.

$1,100,000—**Lockheed Missles & Space Co.,** Sunnyvale, Calif., for work on a classified space project.

$516,881—**United Technology Center,** Sunnyvale, Calif., for demonstration of an advanced solid fuel.

$500,000—**Amcel Propulsion Co.,** Asheville, N.C., for development of a controllable solid propellant rocket motor.

$450,000—**Microdot, Inc.,** South Pasadena, Calif., for a quantity of RF power calibrators to be distributed by Newark Air Force Station Calibration Div. to U.S. Air Force calibration laboratories throughout the world.

$180,390—**E. I. DuPont de Nemours and Co., Inc.,** Wilmington, Del., for development and test of advanced high-energy solid propellants.

$149,518—**Thiokol Chemical Corp.,** Denville, N.J., for study of vacuum hypervelocity.

$92,833—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., for a study of endotbermic fuel for use with *Atlas* booster systems.

$85,672—**Consolidated Systems Corp.,** Monrovia, Calif., for development of a pressure transducer calibration system.

$37,800—**University of Texas,** Austin, Tex., for research and reports on biomedical effects of exposure to radiation.

$32,285—**Space Age Materials Corp.,** Woodside, N.Y., for study of very-high-temperature tbermocouples.

$29,972—**URSA Research Associates,** Newport Beacb, Calif., for development of the "Ursonic welded fiberglass" technique.

$25,744—**Rocket Research Corp.,** Seattle, for evaluation of new materials for construction of valves for control rockets using bigh-energy gaseous propellants.

Melpar, Inc., Falls Church, Va., for study of the intersection of low-energy, monoenergetic electron and molecular beams with regard to the optical excitation of air (amount undisclosed).

ARMY

$2,100,000—**American Telephone & Telegraph Co.,** New York City, for *Nike-Hercules* missile system modification kits.

$2,100,000—**IBM Corp.,** Endicott, N.Y., for automatic data processing machines.

$1,800,000—**Sperry Rand Corp.,** Great Neck, N.Y., for R&D work on Project Defender ABM program.

$164,057—**General Dynamics Corp.,** Pomona, Calif., for additional funding for facilities related to *Redeye* missile R&D work.

$60,595—**Perkin-Elmer Corp.,** Norwalk, Conn., for design, fabrication and checkout of two ground-based optical instrumentation systems.

NAVY

$5,500,000—**Bendix Corp.,** North Hollywood, Calif., for sonar sets and components.

$5,300,000—**Atlantic Research Corp.,** Alexandria, Va., for more than 600 improved sustainer motors for the Navy's *Terrier* surface-to-air missile.

$1,500,000—**Interstate Electronic Corp.,** Anaheim, Calif., for test instrumentation related to the *Polaris* missile system.

$1,300,000—**Radio Corp. of America,** Moorestown, N.J., for R&D work on a 500-kw transmitter for use in space surveillance systems.

$1,300,000—**Minnesota Mining & Manufacturing Co.,** St. Paul, Minn., for R&D work on high-energy oxidizers.

$1,200,000—**Sperry Rand Corp.,** St. Paul, Minn., for one microelectronic computer system.

$235,000—**Operations Research, Inc.,** Silver Spring, Md., for theoretical analyses of existing and proposed undersea weapons systems.

$49,555—**Sweetman Research, Inc.,** Houston, for R&D work to determine feasibility of halogen fluoride devices in ASW operations.

$35,000—**Marshall Laboratories,** Torrance, Calif., for the design, development and fabrication of a state-of-the-art non-contact brusbless sbaft input analog-to-digital encoder with 15-bit resolution in a single turn of the input shaft.

Computer Control Co., Inc., Framingham, Mass., by the U.S. Naval Engineering Service Unit, Pbiladelphia, for a digital computer maintenance trainer to train engineers to maintain and program the digital computer portion of various weapon systems (amount undisclosed).

NASA

$500,000—**Aerojet-General Corp.,** Azusa, Calif., for incremental funding for the SNAP-8 program.

$500,000—**Marshall Laboratories,** Torrance, Calif., for the design, development, fabrication, assembly and testing of prototype and flight instruments for a plasma probe to be used in the *Pioneer* project.

$446,979—**General Dynamics Corp.,** Fort Worth, Tex., for option related to Phase II of a program to develop a pyrotechnic shroud separation system for the *Mariner C* spacecraft.

$400,000—**USAF Systems Command,** Los Angeles, for initial funding for *Atlas* missile improvement program.

$99,900—**Thiokol Chemical Corp.,** Elkton, Md., for R&D of a high specific impulse solid propellant.

$81,200—**Antlah, Inc.,** Worthington, Ohio, for two antenna mounts and control systems.

$73,913—**United Aircraft Corp.,** Pratt & Whitney Aircraft Div., East Hartford, Conn., for determination of emissivity of materials for radiators for nuclear electric power generating systems.

$69,988—**Monitor Systems, Inc.,** Fort Washington, Pa., for modification of digitized systems.

$35,067—**Bryant Computer Products,** Walled Lake, Micb., for a magnetic drum storage system.

$27,022—**Melpar, Inc.,** Falls Churcb, Va., for research covering viscoplastic solution of hypervelocity impact by low density beterogeneous projectiles.

$25,771—**Tektronix, Inc.,** Orlando, Fla., for oscilloscopes.

Vitro Corp. of America, West Orange Laboratory, West Orange, N.J., two contracts to provide the *Apollo* program's Merritt Island Launch Area with countdown and timing systems (amount undisclosed).

INDUSTRY

$4,460,000—**General Precision, Inc.,** Aerospace Systems Div., Little Falls, N.J., from **The General Electric Co.,** re-entry systems dept., Philadelphia, for the design and development of six sets of inertial measuring units plus related aerospace ground equipment for use in an MBRV program.

$3,000,000—**Atlantic Research Corp.,** Production Div., Gainesville, Va., from **Lockheed Missiles and Space Co.,** Sunnyvale, Calif., to produce two types of solid-propellant auxiliary rocket motors for the Navy's A-3 *Polaris* fleet ballistic missile.

$1,000,000—**Raytheon Co.,** Lexington, Mass., from **Radio Corp. of America,** Burlington, Mass., to develop and produce power amplifiers that will transmit astronaut's findings from the Moon's surface.

$416,000—**Hughes Aircraft Co.,** Fullerton, Calif., from **Bunker-Ramo Corp.,** Canoga Park, Calif., for production and testing of 30 mortar-locating radar target simulators.

$284,000—**Aluminum Co. of America,** Lafayette, Ind., from **The Boeing Co.,** Seattle, for electronic cabinet side panel extrusions for use in the *Minuteman* launch facility.

$76,000—**IIT Research Institute,** Chicago, from **Sandia Corp.,** Albuquerque, N.M., for a 12-month investigation of three methods for growing single-crystal thin films on arbitrary substances.

ARMS CONTROL AND DISARMAMENT AGENCY

$235,000—**Sylvania Electric Products, Inc.,** Mountain View, Calif., for a study identifying and defining the factors contributing to a workable and efficient inspection system for use under possible arms control and disarmament agreements requiring verification of retained levels of tactical forces and armaments.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Research and Development Procurement Office
U.S. Army Engineer Research and
Development Laboratories
Fort Belvoir, Va. 22060

Negotiation will be conducted with Space and Information Systems Div., Raytheon Co., 400 N. Wasbington St., Alexandria, Va., for the simultaneous determination of geocentric positioning and orbital parameters from single camera. For information only.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif. 94035

Study to develop optimum materials and techniques for the use of multiple layer insulation for temperatures from 70 degrees to 1,000. RFP 8994 due 7/1/64.

Research Technology Division
Wright-Patterson AFB, Ohio

Negotiation will be conducted with Systems Researcb Laboratories, Dayton, Obio for engineering and fabrication services in laser technology. RFP not available. For information only.

Directorate of R&D Procurement
Systems Engineering Group, RTD
Wright-Patterson AFB, Obio

Negotiations will be conducted with Westinghouse Electric Corp., Baltimore, for a research program on performance of a matrix receiver. RFP not available. For information only.

Directorate of R&D Procurement
Systems Engineering Group, RTD
Wrigbt-Patterson AFB, Ohio

Negotiations will be conducted witb TRG, Inc., Melville, N.Y., for a research program on laser radar tests. For information only.

Bureau of Naval Weapons
Washington, D.C. 20360

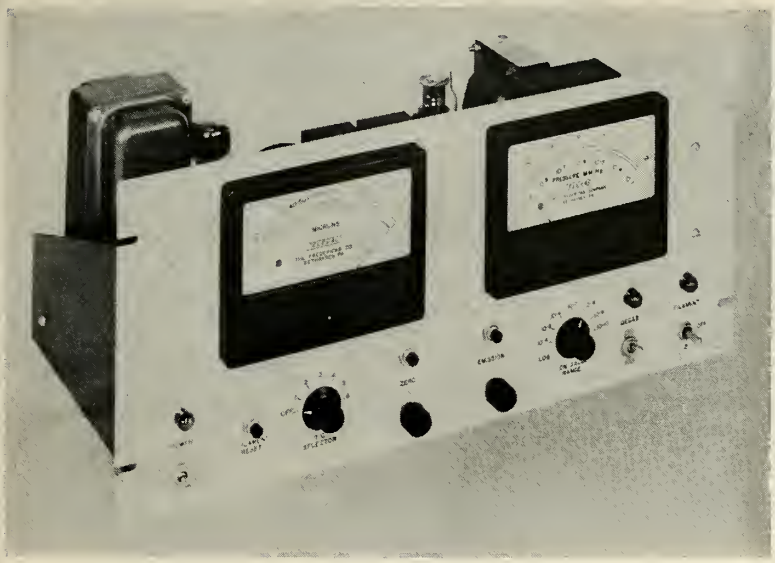
Research and development effort in support of improved *Polaris* launcher concepts. To be solicited from Westinghouse Electric Corp., Sunnyvale, Calif. For information only.

U.S. Army Missile Command,
Procurement and Production
Directorate, Procurement Operations Office
Systems Contracts Division A
Negotiation Branch 2
ATTN: AMSMI-IWB,
Redstone Arsenal, Ala. 35809

Negotiations will be conducted for a contract with Polarad Electric Corp., 4320 34th St., Long Island, N.Y. for two items of portable auxiliary test equipment for the *Hawk* missile system. RFP not available.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Langley Researcb Center is negotiating a contract with the Bendix Corp., Southfield, Micb., for the research and development of a solid-propellant hot gas secondary injection control system. RFP not available. For information only.



New Product of the Week:

Ionization Gauge

A hot filament ionization gauge for high vacuum measurements from 10^{-3} to 2×10^{-11} torr in seven ranges is available from Televac Div., The Fredericks Co.

The Model 3A7-L features a six-decade logarithmic scale that makes it possible to take pressure readings from 10^{-3} to 10^{-9} torr without range changing. The meter scale covers 120% of the pressure range, thus eliminating the problem of overshoot when changing range. Circuit is adjustable from 20 to 200%.

Circle No. 151 on Subscriber Service Card

Frequency Meter

A frequency meter developed to cover the 3.3 to 4.9-gc band is being marketed by Electronic Specialty Co.

Designated the type TR-82079, the unit is direct reading, with subdivisions every 2 megacycles. It is calibrated every 50 mc, has a bandwidth of 0.5 mc and cavity Q of 8,000. Accuracy is 0.03% (error in dial reading at 25°C).

Circle No. 152 on Subscriber Service Card

Clarifier Unit

Anocut Engineering Co. has developed a clarifier unit for use in electrochemical machining. The device has a capacity of 950 gal. and supplies clean electrolyte at the rate of 24 gallons per minute. Machining current rate is 10,000 amperes (one cubic inch per minute metal removal rate).

The unit is essentially a settling tank that separates the products of metal decomposition. Both conductive and nonconductive dirt are removed. The electrolyte is clarified by use of a series of plastic membranes which cause particles to be carried to the bottom of the unit. Settled solids are drained away in periodic cleanings of the hopper.

Circle No. 153 on Subscriber Service Card

Oscilloscope

A compact oscilloscope, which measures 8¼ x 5 x 18¾ in., is available from Technical Products Div., Benrus Corp.

Operating flexibility is possible through plug-in vertical and horizontal amplifier modules and plug-in sweep modules. Sweep rates are from 0.02 cps to 10 kc. Operation is from dc to 500 kc.

Circle No. 154 on Subscriber Service Card

Servo Chart Drive

B&K Instruments, Inc., is marketing the Model 130 servo chart drive, designed for accurate polar level recording when the directional position of the polar chart must be servo-synchronized to the signal source.

The unit has a maximum dynamic error of —0.5 degrees at chart speed of 10 degrees/sec. Maximum static error is ±0.2 degrees. Standard drive ratio is 1:1; other ratios are available.

Circle No. 155 on Subscriber Service Card

3-DB Coupler

Radiation Systems, Inc., is marketing an 8 to 1-band, 3-db coupler, the Series 2633.

The unit is a four-port strip transmission line component which operates over a 100 to 8,000-mc frequency range in four bands. Maximum output imbalance is ±0.5 db. The Model 2633-01 operates from 215 to 1,720 mc with a minimum isolation of 22 db and a maximum insertion loss of 0.3 db.

Circle No. 156 on Subscriber Service Card

Temperature Chamber

A 700-cu.-in. chamber designed for temperature testing of components in electronics, chemicals, plastics and many materials research applications is available from Statham Instruments, Inc.

The Model SD9 utilizes a solid-state proportional controller to maintain a control accuracy of ±1°F over a range of —100° to 500°F.

Circle No. 157 on Subscriber Service Card

Servo Analyzer

A portable servo analyzer, featuring a dual meter to permit phase and response measurements without the use of an accessory oscilloscope, is being marketed by Military Electronics Div. of Ling-Temco-Vought, Inc.

The Model 301 is a solid-state instrument with a frequency range of 0.005 to 1,200 cps. Sine wave, step and ramp driving functions are available direct or may be employed to modulate an external carrier with the built-in mod-



ulator. Specifications include: frequency accuracy, 1% ±1 increment of dial reading; output voltage, 0.02 to 20v, peak-to-peak; output impedance, 600 ohms; attenuation, ±0.2 db; input requirement, 18 watts, 105-125v, 50 to 400 cps.

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Omni-directional Antennas

Jasik Laboratories, Inc., is marketing a series of circularly polarized omni-directional antennas, each covering a full waveguide bandwidth. The series 301C (coaxial inputs) or 301W (waveguide inputs) are offered for frequencies from S-band to 40 gc.

Typically, the X-band 301C operates from 7.5 to 11.0 gc with an axial ratio of less than 3.0 db and a VSWR of less than 1.9:1. Deviation from omni-directionality for any linear polarization is less than ±0.75 db.

Circle No. 159 on Subscriber Service Card

Oscillator

Hill Electronics, Inc., is marketing an oscillator with a 1-mc frequency and output of 0.2v into 50 ohms resistive load. Stability is delta f/f: 1 x 10^{-9} per day. The unit measures 2 x 2 x 5 in. and has a temperature range of —40° to 66°C.

Circle No. 160 on Subscriber Service Card

Arc Image Furnace

Mt. Vernon Research Co. has available a vacuum xenon arc image furnace that can achieve temperatures up to 4,000°C in vacuum, air or inert gases.

A 10,000-watt xenon lamp is located at the focus of a parabolic mirror mounted in a 30-in. vacuum chamber. Another mirror concentrates the beam onto the sample. Average radiant heat flux of more than 550 Btu/ft.^{2}-sec. can be achieved on a sample 0.6 in. in diameter.

Circle No. 161 on Subscriber Service Card

Booster Amplifier

A 100-watt booster amplifier, designed for continuous applications requiring full power at high and low frequencies, has been introduced by Bogen Communications Div. of Lear Siegler, Inc.

The Model M0100A provides 100 watts of output from 25 to 40,000 cps at less than 5% distortion. Frequency response is 8 to 50,000 cps ±1 db. Damping factor is better than 5:1. Outputs are 25v and 70v balanced, center-tapped, 16 ohm balanced. Industrial output is 115v.

Circle No. 162 on Subscriber Service Card

Dilatometer

Dynatech Corp is marketing a fused silica dilatometer, the Model LE-N30-4V-ER.

The instrument measures a sample 2 in. long with cross sections to ½ in. in diameter from —300° to 3,000°F to an accuracy of ±2%. Instrumentation includes chromel-alumel thermocouples for readings up to 2,000°F and platinum-rhodium thermocouples for up to 3,000°F. Power requirements are for 110v ac, 4 kw maximum.

Circle No. 163 on Subscriber Service Card

Power Supply

Weltek Div. of Wells Electronics, Inc., has available a power supply that can be used on microminiature spot welding, seam welding and diffusion bonding.

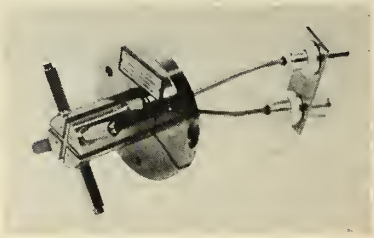
The arc welder has a stable 1,000-cycle source, full up slope and down slope control and a variable pulse from 10 to 800 ms. Input voltage requirement is 100 to 130v, 55 to 65 cps, single phase.

Circle No. 164 on Subscriber Service Card

Crossed-Dipole Antenna

Advanced Development Laboratories, Inc., is marketing a telemetry crossed-dipole antanna.

The Model 02-54 is capable of being tuned from 1,700 to 2,400 mc. It



weighs less than one pound and measures 7⅜ in. long with a 3-in.-diameter mounting flange. Dipole arms are adjustable from 3 to 3½ in. Each dipole may be separately excited through two type N connectors. Isolation between sets of dipoles is greater than 24 db.

Circle No. 165 on Subscriber Service Card

Electronic Panel Meters

Trio Laboratories, Inc., is marketing a line of "Build-in-Bloc" modular electronic panel meters for design and production of measuring and monitoring instruments.

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CONVY


MELLOR


PAGE


CORREA


CRANE

Ernest A. Goetz: Appointed vice president of the Arma Div. of American Bosch Arma Corp., Garden City, N.Y.

T. C. Wisenbaker: Named vice president and general manager of the Missile Systems Div., Raytheon Corp., Lexington, Mass. He has served the company as a consultant for the past 20 months.

John J. Convy: Appointed manager of the Eastern Region Field Offices and the Washington Office of Aerojet-General Corp., Washington, D.C. He was formerly Washington Manager of the Downey, Calif. plant.

James R. Mellor: Appointed director of applied sciences for Data Systems Div. of Litton Industries, Canoga Park, Calif.

Samuel Ofrichter: Elected vice president of finance for Nytronics, Inc., Berkeley Heights, N.J.

G. W. Conover: Appointed general manager of ITT Cannon Electric S.A., Bornem, Belgium.

John Marschalk, 51, a founder of the Strategic Industries Assn. and its first executive director, died in Hollywood, Calif. Marschalk was a nationally known government relations specialist and an active supporter of small business concerns. He had also served in Washington with Aerospace Industries Assn. and was once assistant to the president of the then Bell Aircraft Co.

Raymond M. Bukaty: Named vice president and general manager of Autonetics' Data Systems Div., Anaheim, Calif. Autonetics is a division of North American Aviation, Inc.

Sam Feinstein: Appointed general manager of Servomechanisms/Inc., El Segundo, Calif.

Esterly C. Page: Elected chairman of the board and chief executive officer of Telcom, Inc., Arlington, Va.

James R. Collier: Named manager of domestic product planning for Raytheon Co., Lexington, Mass.

R. A. Correa: Elected a director of American Machine & Foundry Co., New York City. He is the company vice president for business development.

Herman K. Burgett: Named assistant director of industrial relations for the Electronics Div. of Avco Corp., Cincinnati, Ohio.

R. D. Rowland: Appointed director of industrial engineering and estimating for Hayes International Corp., Birmingham, Ala.

Doyle K. Cavin: Joined California Computer Products, Inc., as programming consultant with headquarters in Washington, D.C.

Dr. Stewart E. Fliege: Joined Computer Sciences Corp., El Segundo, Calif., as manager of the newly created Operational Systems Dept.

Robert G. Adams, John W. Bjerklie and **D. B. Colyer:** Joined the technical staff of Mechanical Technology, Inc., Latham, N.Y.

Neal D. Crane: Appointed divisional vice president of American Machine & Foundry Co., New York City. Crane is deputy director of the Research and Development Div., Springdale, Conn.

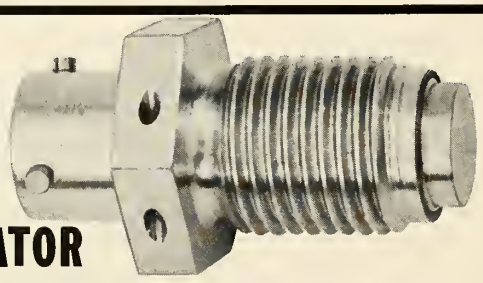
William L. Sparks: Named marketing manager of the Westinghouse Defense and Space Center's Underseas Div., Baltimore.

James M. Badami: Appointed national sales manager for Allmetal Screw Products Co., Inc., Garden City, N.Y.

Carl P. Dudley: Appointed products manager for solid-state devices for Huggins Laboratories, Inc., Sunnyvale, Calif.

Albert Diamond: Named general manager of the Farmingdale Div. of Vernitron Corp., Farmingdale, N.Y.

Stanley Hiller, Jr.: Elected to the board of directors and executive committee of Fairchild Stratos Corp., Washington, D.C. Hiller is founder and president of Hiller Aircraft Co., Inc.



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—when and where—

JUNE

International Conference on Physics and Chemistry, Air Force Office of Scientific Research, Brown University, Providence, R.I., June 21-26.

Seminar on Microcircuit Equipment, Mesa Scientific Corp., Ambassador Hotel, Los Angeles, June 22-23.

67th Annual Meeting, American Society for Testing and Materials, Chicago, June 22-24.

International Conference on Photosensitization in Solids, Air Force Cambridge Research Laboratories, ONR, Space Physics Laboratory and Illinois Institute of Technology, Conrad Hilton Hotel, Chicago, June 22-24.

Seventh Molecular Beam Conference and Institute on Molecular Beams, Air Force Office of Scientific Research, Brookhaven National Laboratory and Uppsala University, Uppsala, Sweden, June 22-July 7.

Conference on Precision Electromagnetic Measurements, sponsored by the National Bureau of Standards, IEEE and International Scientific Radio Union, NBS Boulder Laboratories, Boulder, Colo., June 23-25.

11th Annual Symposium on Computers and Data Processing, University of Denver Research Institute, Elkhorn Lodge, Estes Park, Colo., June 24-25.

Fifth Joint Automatic Control Conference, IEEE, AICE, ASME and ISA, Stanford University, Stanford, Calif., June 24-26.

International Symposium, Fundamental Phenomena in Hypersonic Flow, Cornell Aeronautical Laboratory, Buffalo, N.Y., June 25-26.

1964 Conference on Aerospace Education, National Aerospace Education Council, Hotel Mayflower, Washington, D.C., June 25-27.

First Annual Meeting and Technical Display of the AIAA, Sheraton-Park Hotel, Washington, D.C., June 28-July 2.

Aerospace Reliability and Maintainability Conference, sponsored by the SAE, ASME and AIAA, Statler-Hilton Hotel, Washington, D.C., June 29- July 1.

First International Congress on Vacuum in Space Research, French Society of Vacuum Engineers and Technicians, Paris, June 29-July 3.

JULY

Annual Meeting of the National Society of Professional Engineers, Grove Park Inn, Asheville, N.C., July 1-4.

Seminar in Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries, sponsored by the Contract Measurement Institute, Savoy Hilton Hotel, New York City, July 6-10.

International Symposium on Magnetohydrodynamic Electrical Power Generation, European Nuclear Energy Agency and the Institut National des Sciences et Techniques Nucleaires, Paris, July 6-10.

Concentrated Vortex Motions in Fluids, AF Office of Scientific Research, ONR, NSF, NASA and the International Union of Theoretical and Applied Mechanics, University of Michigan, Ann Arbor, July 6-11.

20th Interagency Solid Propulsion Meeting, Sheraton Hotel, Philadelphia, July 12-15.

National Aerospace Electrical/Electronic Symposium, "Supersonic Aircraft—Avionics at Mach 3 and Beyond," Aerospace Electrical Society, International Hotel, Los Angeles, July 14-15.

Fourth International Symposium on Rarefied Gas Dynamics, sponsored by the AF Office of Scientific Research, ONR, NASA and the University of Toronto, University of Toronto, Toronto, Canada, July 14-17.

Gordon Research Conference on Critical Tables and Progress in Science, Air Force Office of Scientific Research, New Hampton, N.H., July 20-24.

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The Perils of Pluto

THE MUCH-DISCUSSED CROSSROADS in the Pluto program has been reached. It is now directly up to the Department of Defense, and in particular Dr. Harold Brown, Director of Defense Research and Engineering, whether the nuclear ramjet program will proceed down the path toward a nuclear low-altitude supersonic vehicle *(LASV)*.

This moment of truth has been precipitated by two events. First, the completely successful ground firing of the Tory II-C flight-configuration reactor at Jackass Flats on May 20. This left little doubt of the technical momentum behind the program. *LASV* project officials declare that vehicle and engine technology are abreast of reactor development.

The second event is of a more catastrophic nature. Last week the House Appropriations Committee slashed $5.5 million designated for Tory II-C out of the Atomic Energy Commission budget, leaving only $1 million to be used to mothball the project.

The Congressional action may at long last bring to a head the continuing vacillation over *LASV*. Dept. of Defense has until now refused to say whether it feels it is desirable to move Tory II-C into a flight-test program, the next step toward *LASV* development.

One cannot fault the Appropriations Committee for the action taken. The Atomic Energy Commission and the Joint (Congressional) Committee on Atomic Energy have been fully responsive in pushing development of the reactor for the nuclear ramjet missile. Even in the face of DOD reluctance to proceed to flight test, the two groups have shown a willingness to continue funding of Pluto.

Both the Air Force and the Navy have shown an enthusiastic interest in *LASV*. It has been supported before Congress by Gen. Bernard A. Schriever of the Air Force Systems Command and by now-retired Adm. William Raborn, who saw it as a promising follow-on to his highly successful *Polaris* missile. Support for the program continues today at a high level in the services.

Dr. Brown and his associates, while prepared to admit the technical feasibility of *LASV*, are less willing to concede that it would be needed in the nation's military arsenal; they have therefore been hesitant about commitment to a flight-test program expected to cost some $200 million.

There are several alternatives at this point, and the members of the Appropriations Committee quite rightfully have decided that it is time for a showdown. If Pluto is to be saved, DOD will have to go before the Senate Appropriations Committee and ask for reinstatement of the Pluto funds.

One question which can be asked is whether development of the reactor has reached a point where it is capable of flight test—and whether this capability will be lost if it is mothballed.

Gen. A. R. Luedecke, AEC general manager, has this to say: "We believe the Tory II-C technology . . . is an adequate technology to actually produce reactors and engines which will perform the mission . . . Putting it on the shelf would not mean that the technology would be lost."

That, plainly, is one alternative and one which the House committee has raised—to shelve a flight configuration and hope the technology won't be lost.

A second alternative, and one which the Dept. of Defense has shown a disposition to support until now, is to carry the program actively forward on a low key while further study is given to the strategic need for *LASV*. Until the cut last week, the AEC budget carried $6.5 million for Pluto with an additional $12 million in the Air Force budget for development of airframe and engine. If the Senate agrees with the House action, it is hardly likely to approve DOD funds for continued work on the airframe and engine. So, even if it hopes to keep *LASV* on back-burner funding, DOD will have to come to its support.

THE THIRD ALTERNATIVE is for the Directorate of Defense Research and Engineering to state firmly to Congress that there is a military requirement for continued work on the program, with funding for a flight-test program of the *X-15* type planned in the Fiscal 1966 budget.

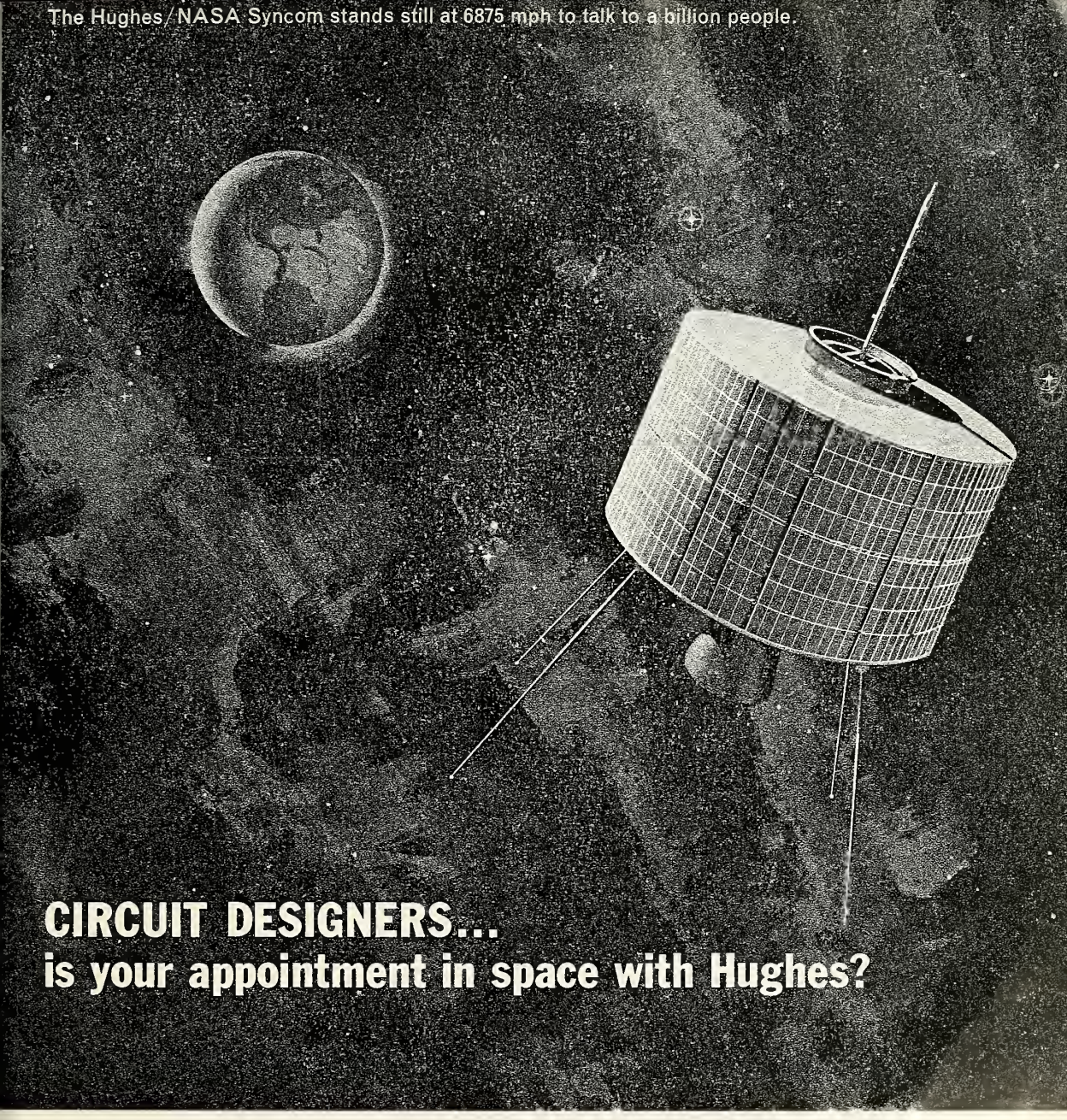
We believe it is time for DDR&E to do just exactly that. If all the talk about technological building blocks is to mean anything, then this building block should be saved.

Development of Pluto has been one of the most successful programs undertaken by AEC and its partners. The very knowledgeable Rep. Chet Holifield of California, vice chairman of JAEC, says this: "I think most of the members of the committee would join me in saying that we hope that a decision will be made to continue this in a reasonable way, notwithstanding the fact that we know there is budgetary pressure on, as always. It seems a shame to go as far as we have along this line and then give up this whole approach. This is the only potentially new weapon system that I am aware of that we might be looking forward to in the future, something beyond what we have now, and something that might take care of some of the increased protection features against higher-flying devices."

We agree wholeheartedly. Some $196 million has been spent on the program to date. The time has come to move into the flight-test program. The AEC has stated that Tory II-C is the reactor it would plan to fly if told to move forward right now as rapidly and reasonably as possible on a flight schedule. As shown in the May 20 test run, Tory II-C has proven its technical feasibility. Ling-Temco-Vought and Marquardt are equally advanced in vehicle and engine development.

A go-ahead now still means four to six years before an actual flight test. Not to proceed would be criminal neglect of the nation's needs.

William J. Coughlin



CIRCUIT DESIGNERS...
is your appointment in space with Hughes?

Today, Hughes is one of the nation's most active aerospace/electronics firms. Projects include: F-111B PHOENIX Guided Missile System, TOW Anti-Tank Missile, SURVEYOR Lunar Spacecraft, SYNCOM, VATE, ARPAT, POLARIS, Hard Point Defense and others.

This vigor will assist the qualified engineers and scientists towards more and better opportunities for both professional and personal growth.

Many immediate openings exist. The engineers selected for these positions will be assigned to the following design tasks: the development of high power airborne radar transmitters, the design of which involves use of the most advanced components; the design of low noise radar receivers using parametric amplifiers; solid state masers and other advanced microwave components; radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits; high efficiency power supplies for airborne and space electronic systems; telemetering and command circuits for space vehicles, timing, control and display circuits for the Hughes COLIDAR (Coherent Light Detection and Ranging).

If you are interested and believe that you can contribute, make your appointment today.

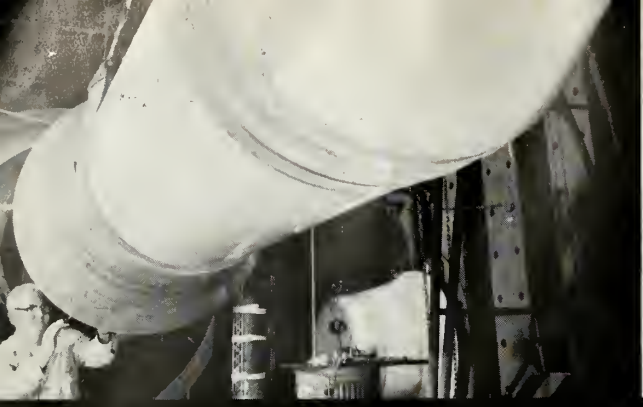
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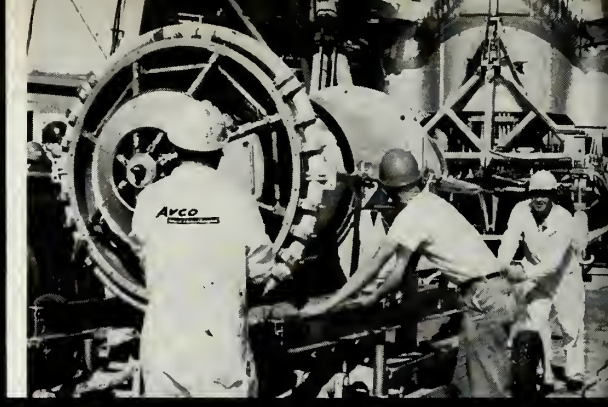
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At Cape Kennedy, Vandenberg and White Sands— Avco/RAD flies the hardware it designs and builds.

This is "hardware flying" with an immediate purpose—to be sure that our re-entry and space vehicles do the job they're intended to do. Permanent RAD personnel at Cape Kennedy, Vandenberg AFB, and White Sands check out and monitor these test flights. They collect the data telemetered by the vehicle during launch, flight, and re-entry. They immediately feed the results back to Wilmington headquarters for complete evaluation of performance and reliability. And so Avco/RAD closes the loop. We start off in the laboratory, solving basic problems. Then we go on to breadboard systems and mock-ups, fabricate full-scale vehicles, test them and fly them. The final result—reliable, operational vehicle systems. *That's what we mean when we say: Avco/RAD is an integrated research and development organization.*

RESEARCH AND ADVANCED DEVELOPMENT DIVISION/WILMINGTON, MASSACHUSETTS

Avco





JUNE 29, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



Preview Of First Annual AIAA Meet

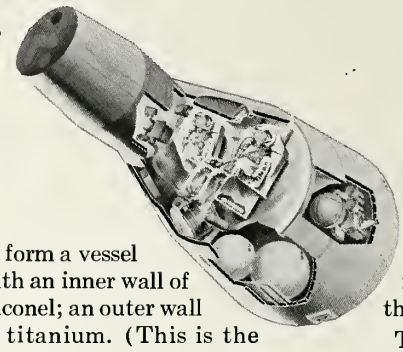
Apollo Contract To Be Extended

Spacecraft Shells Interest Douglas

Martin Sensor Holds Promise

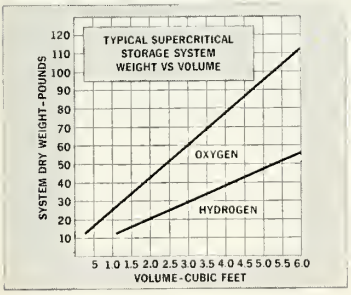
RCA Unveils 'Stabilite'

How do you contain up to six cubic feet of cryogenic fluid in space with a weight loss of only .48 pounds per day? Ask Garrett.



Many companies build cryogenic storage vessels for use on the ground.

But when it comes to life support systems for astronauts or other gas supply systems, there are unique problems which cannot be solved by everyone.



A good case in point is this: Garrett-AiResearch builds cryogenic containers for helium, nitrogen, hydrogen or oxygen that will perform with complete reliability in zero gravity. They are designed to handle all of the requirements for fuel cells, fuel tank pressurization, and environmental systems, from the time of launch through extended space mission.

Developing optimized cryogenic systems for specific applications is a Garrett-AiResearch specialty. Our scientists and technicians have been at it since 1954.

In the process we've developed some exceptional techniques.

A typical example is butt welding two 29-inch titanium hemisphere walls .037 inch thick...matching their peripheral dimensions within ±.002 inch.

Also, dissimilar metals such as titanium and Inconel are joined to form a vessel with an inner wall of Inconel; an outer wall of titanium. (This is the case for oxygen, which can't be stored in contact with titanium.)

Excellence in fabrication is just part of the story.

Garrett-AiResearch also has a quarter century of experience in all phases of heat transfer design, development and production. Garrett builds all the valves, heat exchangers and controls for complete cryogenic systems for any application.

To insure that no contamination enters the containers, one of the most advanced laminar flow clean rooms in the industry was built at AiResearch.

The result of this experience is cryogenic vessels so dependable they won't leak one standard cubic centimeter of gas into their insulating annulus in a 30-year period. (This is required to maintain the low-fluid weight loss described in the headline.)

This kind of technical perfection went into high pressure tanks used by NASA astronauts on Mercury flights. The same precision is going into supercritical storage vessels for Gemini and LEM.

Garrett-AiResearch is at work now on new approaches to storing cryogenics for even more advanced space vehicles.

Established computer programs can rapidly design optimized systems to fit the most rigid requirements. You'll find a quick solution to your cryogenic storage problem at Garrett's AiResearch Los Angeles Division because...

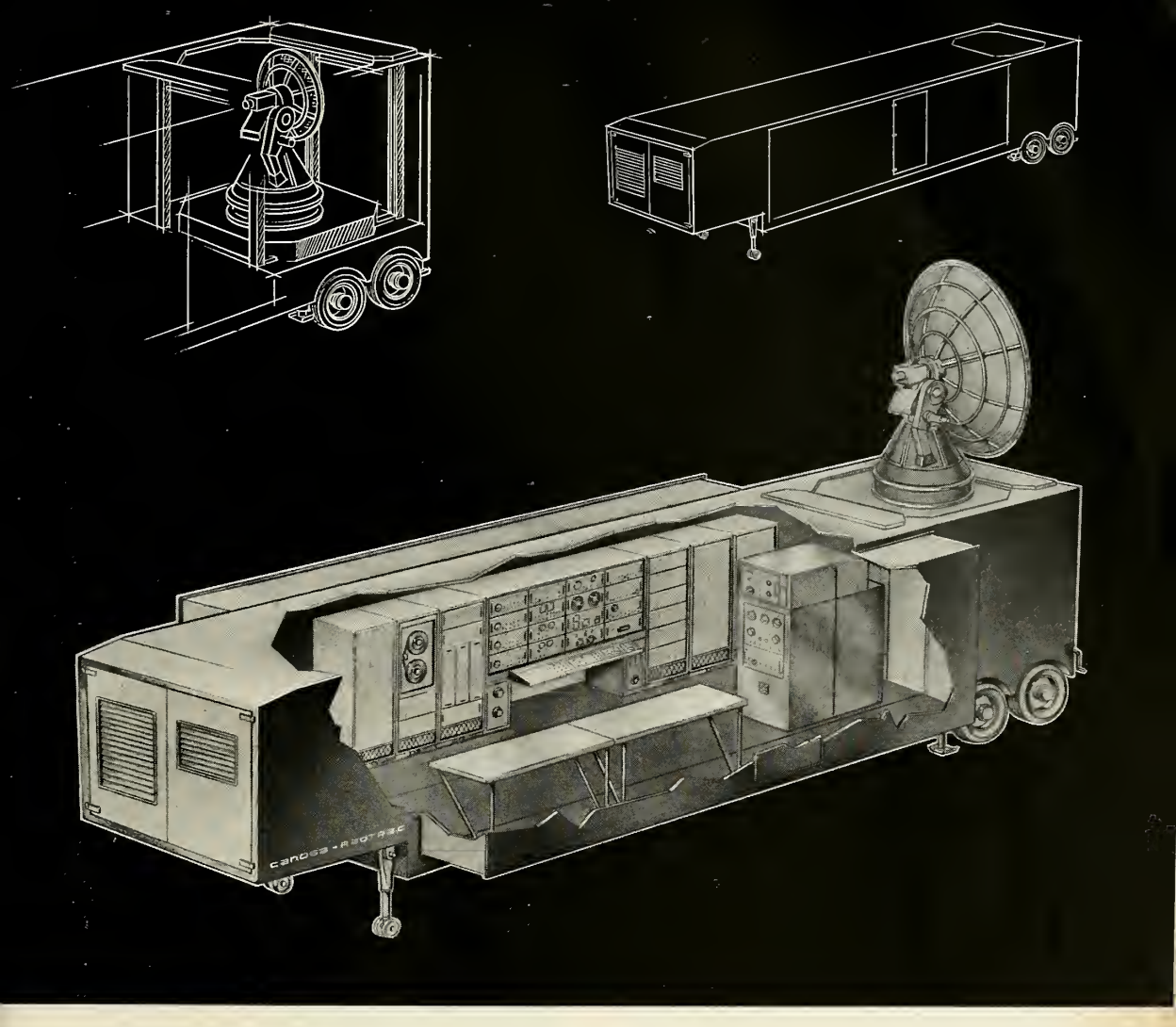
Garrett is experience

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RADTRAC: A New Mobile Tracking Station

canoga



This new mobile air-transportable system can provide complete target tracking data ½ hour after landing. It is an air-conditioned, human-engineered 40-foot van with an up-dated MPS-26 radar, having ample area for maintenance, test equipment storage, auxiliary equipment racks, and mission support equipment to be added as required. Configuration options include... ☐ Customized Digital and Analog Outputs ☐ Teletype Data Formatter ☐ 250 KW or 1 Megawatt Peak rf Output ☐ Low Noise rf Pre-amplifier ☐ 2500 Mile Range Tracker ☐ Fixed Installation or Mobile Version (as shown) ☐ Retractable Antenna for Mobile Installation ☐ S, C, or X Band Frequencies... RADTRAC is an outgrowth of Canoga's comprehensive experience in Mercury and Gemini tracking systems. Write for details.

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SEE A LIVE DEMONSTRATION OF UTC'S HYBRID ROCKET POWER AT THE AIAA ANNUAL MEETING—BOOTH

New space power—the hybrid

Better than three years ago, UTC recognized the potential of the hybrid rocket motor and launched a pioneering company sponsored program to make this power available.

The advantages to be gained: simplicity and reliability of a solid, controllability of a liquid, low-cost, no explosive hazard, higher specific impulse than a solid, higher density than a liquid, wider propellant selections, thrust modulation, stop-start capability—the characteristics of an ideal propulsion system.

Past history of hybrid developments, however, divulged some particularly knotty problems such as poor combustion efficiency, very low burning rates and non-uniform burning of the fuel.

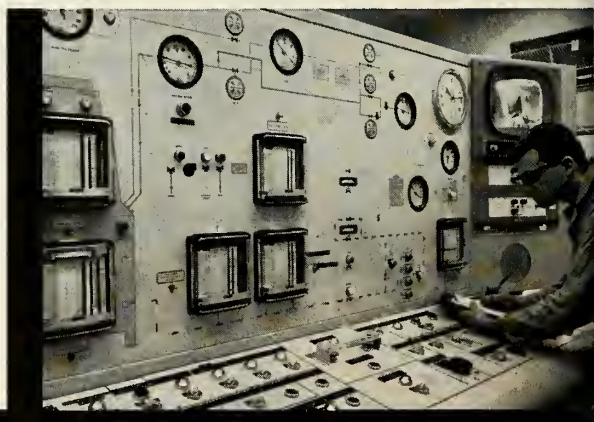
Because of its rapid progress in solving these problems during those early years, UTC gained the support of the Advanced Research Projects Agency, the Air Force and the Naval Bureau of Weapons, and reawakened the interest of the entire propulsion industry.

Primary reason for the unequaled results obtained by UTC in its hybrid rocket program is that company scientists made as their first objective the study of what happens inside such an engine, i.e., the basic phenomena of hybrid combustion.

Because of this advanced knowledge, UTC is now developing a hybrid propulsion system with the highest performance of any in the field employing readily available chemicals; has in over 7,800 test firings of hybrid rocket motors achieved reliability in excess of 99.9%; demonstrated in numerous test firings throttling and stop-start capabilities; designed hybrid rocket configurations capable of performing existing space missions at a cost of 30-40% less than other propulsion systems in use today, and has produced the only hybrid rocket motor that can be test fired publicly because of its safety features.

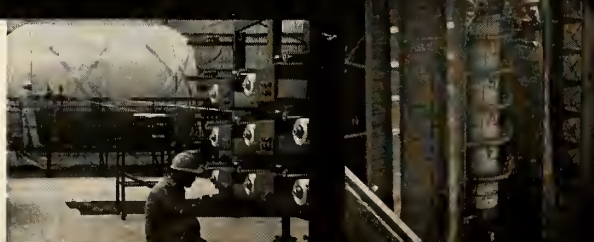
Thus the initial establishment of a sound scientific foundation by UTC, followed by an aggressive development program, has brought the hybrid rocket into the family of practical, predictable and reliable space propulsion systems.

Scientists and engineers at UTC welcome sophisticated propulsion challenges such as this—and welcome others with quiet competence and inquiring minds who seek such challenges.



UTC:
Rocket propulsion
capability over
the full spectrum





United Technology Center

SUNNYVALE, CALIFORNIA
DIVISION OF UNITED AIRCRAFT CORPORATION

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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 14, Number 26 June 29, 1964

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THE COVER



Dr. Robert C. Sclier of RCA's Astro-Electronics Div. views lab mockup of new "Stabilite" attitude control system installed in a hatbox-shaped satellite slightly smaller than Tiros. System is being shown publicly for the first time at this week's AIAA First Annual Meeting in Washington. See story p. 34.

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50,000 copies this issue

THE LASE

The amazing laser makes light beams which weld, measure, balance, heat, survey, detect, communicate, time, sterilize, map, machine, heal, analyse, search, melt. The world's first working laser was built by Hughes.

Even science fiction writers were unprepared for the laser when it burst on the scientific world in 1960. Few would have predicted that man could indeed create light that was coherent – whose waves all "marched in lockstep." Light so coherent that a beam sent from a laser is only a few feet wide ten miles away. Whose energy could be controlled to generate instant heat millions of times hotter than the sun.

Today the laser has caught the imagination of researchers in hundreds of fields. Dentists are "welding" fillings into teeth. Watchmakers are drilling tiny holes in ruby jewels in microseconds instead of hours. The human voice as well as pictures have been transmitted on a laser beam. Experts calculate one beam could carry all the telephone conversations being made at this moment.

One of the first practical uses of the laser is the Hughes Colidar (Coherent Light Detection and Ranging). The first laser rangefinder, it can measure distances with accuracy and speed never before obtainable. Several versions, for use by troops, in tanks and helicopters, pinpoint targets several miles distant.

In the new field of microminiaturization, Hughes laser welders offer clear advantages. Joining the tiny bits of me interconnections between thin fil ments, for example, is virtually i sible with other methods. But th can fuse wires just 0.0005" in dia join dissimilar metals, and ev through the glass envelope of a c tube to weld otherwise inacc connections.

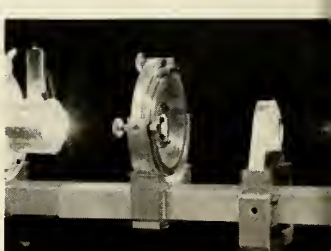
The world's first working laser, b Hughes, used a ruby which "las one color – red. Latest examp Hughes research is the achievem the first "variable" laser which pr 60 new colors. Using a "noble" such as argon, xenon, krypton and



LASER RANGER IN GUN CONFIGURATION FIRES A LIGHT BEAM TO GIVE PRECISE RANGE OF OBJECTS UP TO TEN MILES AWAY – RANGE IS INSTANTLY READ OUT BY OPERATOR



NEWEST HUGHES LASER DEVELOPMENT HAS JUST ADDED 60 COLORS TO THE GAS LASER'S CAPABILITY – FILLING THE PREVIOUS GAP IN LIGHT SPECTRUM. THIS OPENS GREAT NUMBERS OF NEW LASER APPLICATIONS.



AIR SPARK. PRODUCED BY 100,000,000 WATTS FROM LASER, WHEN AIR MOLECULES ARE IONIZED FOR SPLIT

THIN FILM CIRCUIT (RIGHT) OF ALUMINUM IS JOINED B SCOPIC WELDS IN NICKEL RIBBON. THE ABILITY TO W SIMILAR METALS IS JUST ONE OF THE LASER'S ADVAN METALWORKING. (CIRCUIT SHOWN IS TWICE ACTUA

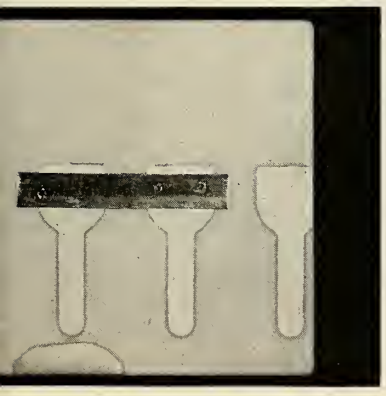
Creating a new world with electronics

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this gas-type laser produces blues, greens, violets, reds and yellows. It opens the visible spectrum for research into a vast number of applications.

Lasers are just one of the advanced technologies in which Hughes is playing a major role. This work – devoted to discovering nature's secrets and making them serve in man's betterment is creating a new world with electronics. *Engineers and scientists* with interest in joining Hughes laser activities, or any of the company's other programs, are invited to inquire. Please write Mr. S. L. Gillespie, Hughes Aircraft Company, Culver City 88, California. Hughes is an equal opportunity employer.



letters

'Withdrawal from Reality'

To the Editor:

In reference to the editorial, "Withdrawal from Reality," (M/R, June 15, p. 46), it is certainly very apparent that Mr. Coughlin has not withdrawn from reality. He demonstrates a highly realistic concern with his own financial stake in the future of expenditures for sophisticated weapon systems.

He labels as "dangerous" an article by Stewart Alsop foreseeing little possibility for future significant advances in weapons development. The implication in this article, a very natural one, is that we have reached the point of rapidly diminishing returns.

Perhaps this estimate is not true, but what is so "dangerous" about it? And are the readers considered so naive as not to perceive the different interests motivating Mr. Alsop and Mr. Coughlin?

The author states: "We have nothing against sensible unilateral reduction of the Dept. of Defense budget if it can be achieved while still meeting the nation's defense requirements."

For those of us who are ill-informed, including the Dept. of Defense, perhaps your magazine could spell out, in a subsequent article, the nation's defense requirements and thereby perform a patriotic service to your country and a monetary service to yourself.

By the way, as a missile worker, I'm also dependent upon the continuing allocation of large sums for a continuing income.

Virgil D. Kilgore
Corinne, Utah

To the Editor:

May we express our compliments on your editorial, "Withdrawal From Reality," (M/R, June 15, p. 46).

Our appreciation takes two forms. First, that the thoughts presented are sound and logically presented—and so necessary to our national survival.

Second, you are to be complimented on the forthright stand made public—which obviously does not coincide with the opinions of the Administration and/or Department of Defense. With such things as postal permits and all other forms of governmental controls and regulations, one flies in the face of danger to express opinions contrary to "the great white father."

While we have benefitted and admired many previous editorials, this particular one moved us to the point of letter recognition—to include the others we have seen and respected.

Robert J. Stein
Manager, Public Affairs
Flick-Reedy Corporation
Bensenville, Ill.

To the Editor:

Having worked on the construction of facilities of the soft-based *Atlas* missile for several years, I am well aware that there is a mentally debilitating germ loose in the land (Editorial, "Withdrawal from Reality," M/R, June 15, p. 46).

Like the fog of the terrain, its symptoms would come and go, and only the sunlight of the Spirit allowed the men to get the job done.

Then, in October, 1962, it seemed to be on the wane, when the President of the United States led us to show our American Spirit.

Then and since then I have found that there is immunization in the mental hygiene of:

If perish we must,
Let it be in the spirit of
"In God We Trust."

Thomas V. J. Brennan
Palm Beach, Fla.

To the Editor:

Your editorial in the June 15 issue ("Withdrawal from Reality," M/R, June 15, p. 46) is the scariest exposure of high-level thinking I've read outside of Ayn Rand's novel, "Atlas Shrugged."

Helen Keller said, "Security is mostly a superstition. It does not exist in nature, nor do the children of men as a whole experience it. Avoiding danger is no safer, in the long run, than outright exposure."

I would agree that security is a shaky concept at best, but who ever heard of a shakier concept than the one you quoted by Prof. Dyson? His reasoning seems to go like this:

A. Russian aggression is caused by fear of the United States.

B. Fear of the United States will be removed by disarming the United States.

C. Therefore, Russian aggression will be removed by disarming the United States.

You can't fault the logic, but the premises leave something to be desired.

There is just one thing that keeps sticking in my mind, however. Look again at Prof. Dyson's statement.

"On our side, security is adequately protected if the analytical computation of thermonuclear exchanges indicate that enough (enough for what, by the way?) of our second-strike force will certainly penetrate the Soviet defenses. On their side, security is adequately protected if the Soviet armed forces have the finest weapons that anybody knows how to build, irrespective of paper calculations."

Listen to the choice of words! The ring of "finest weapons" and the contempt for "paper calculations." It just doesn't fit the context. How could anyone reading that last line possibly accept the argument that preceded it?

With Ayn Rand's book fresh in mind, I wonder if Prof. Dyson's employer directed him to present the main argument, and if that last line is a rather desperate high-sign to readers, like "Help! I am a prisoner in a fortune-cookie factory!"

Is it just my imagination working overtime or have you already checked this out?

(Mrs.) Polly Ryan
Berkeley, Calif.



Nuclear reactors for training and research

Lockheed-Georgia will design and install a training-research reactor to your specific requirements. You can choose from a wide range of power levels and optional features. And we will help you plan your entire nuclear facility, assist you in obtaining your AEC reactor and operator licenses. First step: clip and send the coupon for detailed folder.

Mr. Jack B. Hippler
Lockheed-Georgia Company, Nuclear Laboratory, Dept. 69-12
Marietta, Georgia

Dear Sir: Please send me your technical folder on training and research reactors.

name _____

firm or school _____

title _____

city _____ *zone* _____ *state* _____

The Countdown

WASHINGTON

JPL Will Be Mariner Prime

NASA will allow Jet Propulsion Laboratory to be its own prime contractor on the *Mariner* spacecraft scheduled to fly-by Mars in 1966. Heavy industry subcontracting is expected, however. Details are being worked out in meetings with JPL.

Air Force Seeks New Missile

Air Force study of its requirement for a new, highly accurate air-to-surface missile, or family of missiles, appears to be bearing fruit. A tactical missile office now has been established at Aeronautical Systems Division. Interest is centered on TV terminal guidance schemes with all-weather capability and high accuracy at slant ranges of up to 25 miles.

Aerojet Discloses Recon Rocket

Aerojet-General, in a project called Tattletale, has a quick answer to tactical reconnaissance requirements which could have been designed by Rube Goldberg. A small rocket which can be launched without specialized equipment, the device is fired to altitude over an enemy position. At this point, the rocket and nose cap fall away and a camera suspended from a parachute takes photos of the area. At a preset altitude, the parachute is released and a retro-rocket lofts the camera to an altitude which allows a gas-filled paraglider to carry the payload back to the recovery area.

ARPA Funds Hard Site Radar

Sperry Gyroscope will build an experimental phased array radar at White Sands Missile Range, N.M., as a test device for a hardened site defense system. Funded under ARPA's Project Defender, the radar will consist of the receiver only—presumably the *Nike-X* Multi-function Array Radar (MAR) will furnish the radiated power. Army Missile Command will monitor the program for ARPA.

Total Rover Investment Is Disclosed

Senate Space Committee has revealed that total investment in the *Rover* program through FY 1965 comes to $729.2 million. Of this, $446.8 million was supported by the Atomic Energy Commission and $282.4 million by NASA. Total SNAP program expenditures, by AEC alone, total $354 million.

First Flight Tests of New Missile Due

First flight demonstration of North American Aviation's *ATGAR* air-to-surface anti-tank missile is set for later this year. Texas Instruments holds a guidance contract on the system, under development by NAA's Columbus Division for the Air Force. Initial contract to North American totals $900,000 for first phase of program.

DOD Seeks NASA Exec for MOL

Dept. of Defense has asked NASA to assign one of its top executives to work directly in the management of the Air Force *Manned Orbiting Laboratory* program, in much the same manner that Brig. Gen. Samuel Phillips has been attached to the *Apollo* program. Assignment would be to Air Force Systems Command.

INDUSTRY

GE Finally Gets BioSat Contract

General Electric's Reentry Systems Division finally has received a signed contract from NASA for the *Biosatellite* program. Negotiations resulted in a $24 million award, some $5 million more than estimated when the two agreed to agree last August.

Martin Will Close Bullpup Line

Award of the recent $23.5 million *Bullpup A* and *B* contract to Maxson Electronics means the *Bullpup* line at Martin/Orlando, original prime contractor, will close down shortly. Probable date: about August 1.

Bids Received on Apollo Restraint System

Seven firms have bid on development of a netting type couch and restraint system for Project *Apollo:* North American Aviation, American Machine and Foundry, Goodyear Aerospace, Weber Aircraft, Illinois Institute of Technology Research Institute, Payne and Associates, and Frost Engineering. Netting specifies partially drawn nylon woven to provide permanent elongation points appropriate to varying masses of different parts of the body during either land or water landings.

MSC Evaluates Bids on Extended Apollo

Manned Spacecraft Center procurement officers are evaluating bids from TRW Space Technology Laboratories, Douglas Aircraft, Lockheed and Boeing for the $300,000 design and mockup contract for an extended *Apollo* Laboratory Module (MSC-64-1191p). Requirement grows out of extended *Apollo* studies this spring on feasibility of extending operating life of *Apollo* spacecraft to 120 days. Module would form the basis for the *Apollo* Orbital Research Laboratory and would be usable with either *Saturn 1-B* or *Saturn V*.

Lunar Analyzer Bids Submitted

Northrop, TRW Space Technology Laboratories, Geophysics Institute of America, Melpar, Stanford Research Institute, General Electric and Grumman submitted bids on the Lunar Atmosphere Detection System which is to be soft-landed on the Moon by an astronaut in lunar orbit prior to landing. Design calls for analysis of lunar gases, cosmic radiation, radioactive decay, meteoroid impact outgassing, and photodissociation of chemicals in lunar rocks due to Sun's ultraviolet rays.

INTERNATIONAL

RAAF to Buy Matra for Mirage

Australia has announced it will buy the French radar-guided *Matra* air-to-air missile as main interceptor armament for the Royal Australian Air Force Mirage jetfighters now coming into service. The missile is expected to extend the Mirage all-weather capability.

Japanese Plan to Buy 24 Nike-Ajax

Japan's Air Self Defense Force has decided to buy 24 *Nike-Ajax* missiles and associated ground support equipment from the U.S. Some 300 Japanese officers and men will be sent to the U.S. for training this fall. GSE will cost about $200,000 in addition to outlay for the 24 missiles.



A Princeton tiger that acts like a lamb

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The Stratoscope II Program is supported jointly by the National Science Foundation, the National Aeronautics and Space Administration, and the Office of Naval Research.

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JPL Control Tightened

Announcement of the addition of one or more top-level management executives was imminent at Jet Propulsion Laboratory at the end of last week following the House Space Committee's report urging tighter Government control over the laboratory.

The changes MISSILES AND ROCKETS was told were forthcoming will not necessarily be fully in line with the committee recommendations, however. Top JPL sources pointed out that while the committee may recommend, the laboratory must await direction by NASA.

The staff additions and changes are not being made as a direct result of the recent hearing. "Since the first of the year, following the last investigation, we have been looking at the possibility of strengthening the top-level staff," a JPL source told M/R.

"We have been looking for several people to add to the staff, including a business manager or possibly a general manager. We may or may not add a general manager as the committee report recommended. We have had a deputy, a number two man, for some time."

A spokesman said JPL thinking leaned more toward a business manager type of executive serving as deputy to the lab director than a general manager who would be specifically responsible for such projects as *Ranger* and *Mariner*.

Meanwhile, M/R was told JPL could understand as "logical" the Government wanting stronger control over laboratory projects such as *Ranger* and *Mariner*. A spokesman made a distinction here between the laboratory's project area and its research area. "In general, we agree with the trend toward tighter control over the project area. We have been seeing a general trend toward stiffer contracts where the projects are concerned."

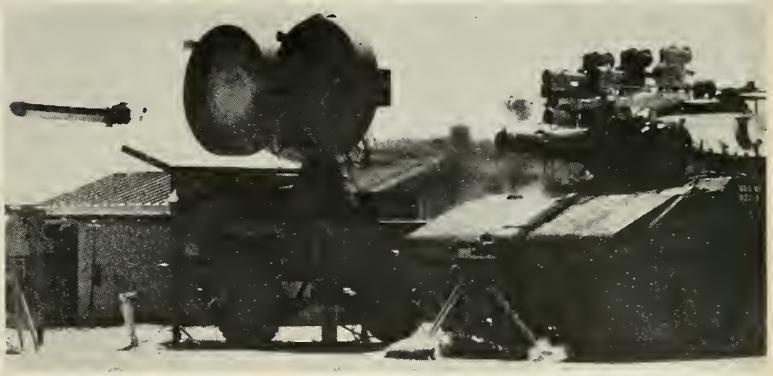
M-1 Malfunctions in Hot Firing

Developmental hardware for the 1.5-million-lb.-thrust liquid hydrogen M-1 engine went through the first hot firing on June 20, but a malfunction in the LOX delivery system stopped the test midway through the planned 3-second run.

Dan E. Price, program manager for the Aerojet-General/NASA engine project said the 1.6-second, uncooled run reached the 800,000 lb. thrust level and provided data on design details. Programmed thrust in the test was 1-million lbs.

Propellants were supplied by high pressure tanks in the test. In actual operation, the engine will use turbo-pumps to force the propellants into the combustion chamber.

The M-1 is slated for operational use in the 1970 period and is under the overall direction of NASA's Lewis Research Center, Cleveland, Ohio.



First Firing of Full Shillelagh System

SHILLELAGH missile heads for target after leaving launch tube of Sheridan reconnaissance vehicle in first test of the complete vehicle and missile system. It took place at White Sands Missile Range, N.M. This was also first firing to use production prototype guidance and control equipment developed by Aeronutronic Div., Philco Corp., Shillelagh prime contractor. All aspects of the firing, a compatability test of the missile and vehicle, were described by Army officials as highly successful. Shot was also 21st straight success for Shillelagh.

MSC Lets Study Pact

Six aerospace firms have bid on a $171,000 feasibility study contract designed by NASA's Manned Spacecraft Center to learn if the *Apollo* spacecraft can carry three astronauts past Mars and Venus.

Ten firms are seeking a study contract to determine what ground or orbital support facilities would be needed for such a 400 to 600-day mission.

William J. Stoney, chief of advanced spacecraft technology at MSC, has specified a seven-month study aimed at the period 1971-75, when Venus and Mars would be in the best position for a dual fly-by. Additional living room for the astronauts, supplies, and instruments for surveying the planets during a pass of less than an hour by each would be provided at relatively low cost by replacing the Apollo's Lunar Excursion Module with an Orbital Research Laboratory module.

The fly-by mission contemplates use of three to four *Saturn V* launches and assembly of equipment, including a space booster rocket, in orbit.

However, bidders on the mission support contract were asked to consider an alternate mission involving orbital capture of Mars with both chemical and nuclear propulsion.

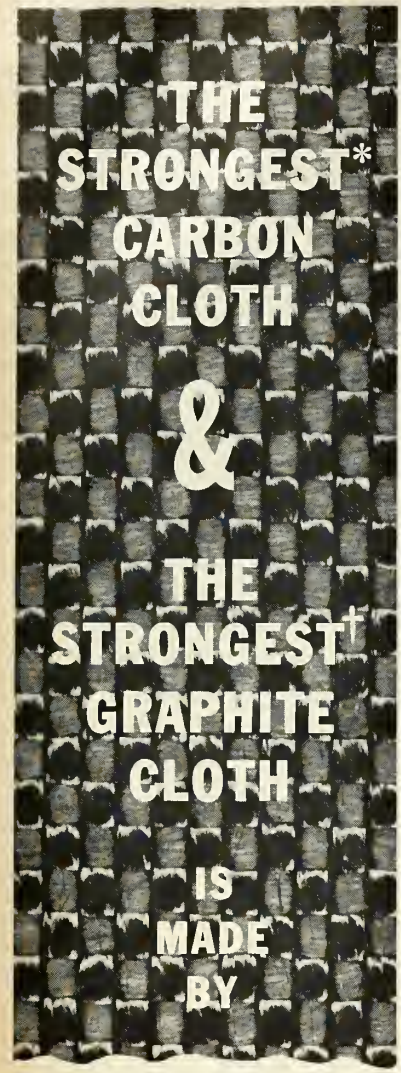
Bidding for the Mars-Venus fly-by study are General Dynamics, Grumman, United Aircraft Research Laboratories, Lockheed Missiles & Space Co., Honeywell, and North American Aviation.

Bidders for the support contract include General Dynamics, Douglas, Lowell Technological Institute Foundation, Northrop, Boeing, General Electric, TRW Space Technology Laboratories, and North American Aviation.

GD-STL Team Seek MOL

General Dynamics/Astronautics and TRW Space Technology Laboratories will bid as a team on the Air Force *Manned Orbiting Laboratory* (*MOL*) program (M/R, May 11, p. 7).

The announcement was made jointly by the presidents of the two companies, who pointed out that the



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two firms had worked successfully together on past major aerospace programs, mainly the *Atlas* program.

Under the GD/A-TRW arrangement, the General Dynamics division is the prime organization for the *MOL* bidding and has overall responsibility with specific areas of work, including life support systems and production. TRW is a subcontractor in this arrangement and will handle systems engineering and do development work in such areas as electronics and data management.

The firms have appointed two of their top officials to head the *MOL* work of the respective organizations. They are Mortimor Rosenbaum, vice president and program director for manned space systems at GD/A and Dr. E .B. Doll a vice president of STL. Rosenbaum and Doll have worked together in engineering, production and management of aerospace systems during the past ten years.

J. R. Dempsey, president of GD/A, said, "We feel the Air Force requirements for strict management and technical control of the *MOL* program under their overall direction can be met through the complementary skills our two organizations have in those areas."

Ranger Scrutiny Continues

NASA officials say that space agency headquarters staff members will continue close supervision of the *Ranger VII* spacecraft up to the time of its launch—now set for late July or early August.

The craft recently arrived at Cape Kennedy from the Jet Propulsion Laboratory, Pasadena, Calif., and is being readied for a series of tests with the *Atlas-Agena* launch vehicle.

Shots of the Week

The Air Force on June 18 launched two shots from Vandenberg AFB, Calif. One, an *Atlas D* ICBM, successfully lofted a dummy warhead 5,000 mi. down the Pacific Missile Range; the other was a *Thor-Agena* combination carrying a satellite of undisclosed type toward polar orbit.

- The Soviet Union launched *Cosmos 33*, on June 23, another in a series of scientific satellites. Apogee was 293 km; perigee, 209 km. The satellite had an inclination to the Earth's equitorial plane of 65 degrees.
- A two-stage French *Rubis* rocket reached an altitude of 1,800 km when fired from the Hammaguir launching base on June 10. The *Rubis*' first stage is an *Agate* rocket, and the second stage is the third stage of *Diamant*, the all-French satellite launcher.

DOD Opposes Conversion Bill

A bill to establish a National Economic Conversion Commission to study ways of cushioning the community impact of cutbacks in defense spending is being opposed by the Dept. of Defense.

Basically, the opposition to S. 2274—introduced by Sen. George S. McGovern (D.-S.D.) and co-sponsored by more than a dozen other senators—stems from a feeling that the commission would only duplicate efforts being conducted by already existing Government agencies.

Specifically, DOD opposes Section V of the bill, which would require contractors to establish committees within their organization to plan for conversion to civilian work in the event of a cutback or termination of their Government work. "Aside from our belief that this . . . is far too broad in its application," Deputy Secretary of Defense, Cyrus Vance testified before the Senate Commerce Committee, "we do not believe this provision will have the desired effect." DOD is already encouraging contractors to do the necessary long-range planning to anticipate changes in defense procurement, he pointed out.

Centaur Delayed

An RL-10 engine swiveled to the wrong position during prelaunch testing of the *Centaur* launch vehicle June 24 and prompted a one-day delay in the third firing of the hydrogen/oxygen-fueled vehicle.

The launch was re-scheduled for June 26 to permit replacement of the swivel actuator and servoamplifier on the offending engine. The decision to replace the units was made despite several satisfactory trials of the engine swiveling system subsequent to the malfunction.

Navy Solicits Apollo Proposals

Eleven firms have been requested to submit proposals for installation of electronics equipment in, and conversion of, three T-2 tankers to be used as tracking ships in the *Apollo* program. The requests were sent out last week with proposals due Aug. 24.

The eleven firms were: ITT Federal Laboratories, Nutley, N.J.; Philco Corp., Palo Alto, Calif.; Radio Corporation of America, Moorestown, N.J.; Sperry Rand Corp.,

Great Neck, N.Y.; Northrop Corp., Needham Heights, Mass.; General Dynamics/Astronautics, San Diego, Calif.; Bendix Corp., Ann Arbor, Mich.; Ling-Temco-Vought, Inc., Dallas; Westinghouse Corp., Washington, D.C.; Raytheon Corp., Waltham, Mass.; and Lockheed Aircraft Corp., Burbank, Calif. These firms, the Navy said, were selected as a result of managment proposals they submitted earlier this year.

The program is managed for the Navy by the Instrumentation Ships Project Office, Office of Naval Material. Capt. A. F. Hancock, USN, is the Project Manager.

NASA Seeks ATS Experiments

The National Aeronautics and Space Administration has sent letters to approximately 1,000 scientists in an effort to get experiments for a series of five *Advanced Technological Satellites*, which will be launched between 1966 and 1968.

The first satellite will probably carry only three or four experiments, as NASA will seek to discover how experimental "booms"—affect stability of the gravity-gradient stabilization system. About 25 lbs. of payload will be available for experiments.

The first satellite will weigh 780 lbs., and will be put into a 6,900-mi. orbit sometime in early 1966. Primary objective will be to test the gravity gradient system. Launch vehicle is the *Atlas-Agena*.

Second and third launches, expected at six-month intervals after the first, will carry satellites to 22,300 mi. in equatorial synchronous orbits. These will be spin-stabilized and will be aimed at evaluating advanced communications techniques, meteorological components, and station-keeping.

Fourth and fifth *ATS* satellites will be similar to the second and third, but will combine the gravity gradient stabilization technique.

Gemini Engines Installed

The liquid rocket engines for the first manned *Gemini* flight have been installed in the launch vehicle at Martin Co.'s Baltimore facility.

The Aerojet-General powerplants, a two-barrel 430,000-lb.-thrust first-stage unit, and the 100,000-lb.-thrust second-stage engine were accompanied on the trip to Martin by Aerojet's James F. Toohey—the "Guardian Engineer" who oversees the engines from manufacture to launch. The next major step is shipment of the *Gemini* launch vehicle to Cape Kennedy.

Regs Stress Responsibility

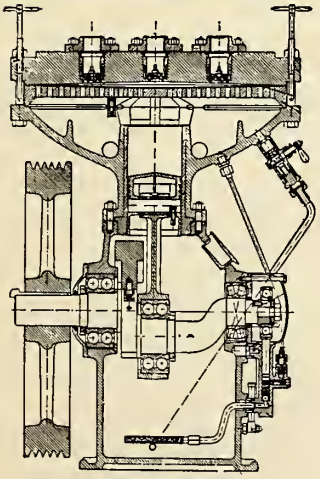
Responsibility has been given new emphasis in Department of Defense Procurement Circular 9, issued June 18 and effective immediately.

In determining the award of a contract in a competitive procurement, the lowest bidder, even though also responsive to the request for bid, need not be awarded a contract if a specific determination of responsibility cannot be made. Even in the case of "*doubt* as to productive capacity or financial strength," a written determination of nonresponsibility will be required.

A revision to Section 1, Part 9 of the Armed Services Procurement Regulations, the circular emphasizes that the general obligation of a procurement officer to buy for the Government at the lowest price does "not require an award to a marginal supplier solely because he submits the lowest offer." Prospective contractors must demonstrate "affirmatively their capability to fulfill successfully the contemplated contract."

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Apollo Add-on Is $500 Million

Number of new spacecraft not disclosed in NAA, MSC negotiations; details of up-dated lunar mission schedule

by Warren Burkett

HOUSTON—NASA'S Manned Spacecraft Center and North American Aviation, Inc., will begin negotiations this week to extend the *Apollo* spacecraft contract. The current $934.4-million contract expires in May, 1965. The extension, expected to top $500 million, will run through the spring of 1966.

MSC officials said it was impossible to estimate now the number of spacecraft involved in the new contract. The present one calls for 15 boilerplates and 11 spacecraft.

None of the spacecraft now under contract will fit the configuration for the lunar mission, lacking Lunar Excursion Module (LEM) adapter sections and, in certain cases, the tunnel crawlway by which astronauts would enter the LEM.

● **New flight details**—MSC released new details on the testing and flight schedule for Project *Apollo:*

Ten flights by the *Saturn 1B* are planned. The first two will be sub-orbital to test the launch vehicle and the re-entry of the craft. The next series of flights will carry astronauts on long-duration flights with the Command and Service modules only.

These long-duration flights will last 10 to 14 days and will include plane-change maneuvers that could put the vehicle into a polar orbit or a highly inclined orbit.

Later flights will include the lunar-configured *Apollo,* LEM and Service Module. Flights will last about three days and cover LEM maneuvers, rendezvous and docking.

● **Disagreement**—NASA hopes to qualify the *Saturn V* Moon rocket with two flights. On each, the *Apollo* will be carried out to a highly elliptical orbit and flown back to Earth at high speed to qualify the heat shield at simulated re-entry speeds from the lunar journey. Less optimistic estimators believe as many as five launches may be needed.

The first eight *Saturn V-Apollo* manned flights will remain in Earth orbit. Astronauts will conduct experiments in flight as well as practice navigation and LEM maneuvers.

One or more of these flights, according to MSC sources, may take the astronaut crew into a highly elliptical Earth orbit that would approach the Moon and perhaps circle it. This would offer the opportunity of replacing the LEM with a reconnaissance module equipped for photographic and electromagnetic surveys.

The first attempts to reach the Moon could not come, under the present schedule, before the ninth *Saturn V-Apollo* flight. Dr. Joseph Shea, *Apollo* project manager, said recently that the most likely time for this flight was during the early part of 1969.

● **1969 launch windows**—Christopher Kraft, assistant director for flight operations at MSC, has identified five months of 1969 as offering the best launch windows for the lunar expedition constraints of 1) launching one-half hour after sunrise or before sunset, 2) appropriate lighting upon the Moon at time of arrival, and 3) tracking requirements at the time of insertion.

These tracking requirements include at least three minutes of tracking, following insertion, by a single ship in the Atlantic to confirm orbit. The constraints also establish two injection (lunar) opportunities within 4½ hours after insertion. Three successive launch windows are specified in case of hold due to weather in the launch area.

Best months for launch in 1969 are April, May and June in the latter half of the month and July and August toward mid-month. ■

Jackson Presses for Pluto Revival

SEN. HENRY M. JACKSON has told the Senate that he intends to fight for continuation of the Pluto nuclear ramjet engine project (M/R, June 22, p. 46).

The Washington Democrat said he was concerned about the fact that the House, in passing the public works appropriations bill, left only $1 million for the project. He called for the Senate to restore the funds cut ($5.5 million).

"While I hope that the Defense Department will decide to support a flight test of the nuclear engine, I am concerned that the extreme cut, made by the other body, will not permit scientists to carry the program to a logical termination point if a decision is made not to support the flight test," Jackson told the Senate.

The senator added that he would have more to say when the appropriations bill did reach the Senate. "I am concerned that a drastic cut in the level of support for this program would make it impossible for us to correlate the technical information developed for possible future use," he said.

Jackson said that the Dept. of Defense, after completing a study, is expected to make a decision by July 1 as to whether it will support a flight test of the successful nuclear engine. "I strongly believe that such a flight test should be conducted, to fully demonstrate the unique characteristics of what could become a revolutionary weapon system. Past experience has amply demonstrated that requirements for new weapons systems come about after a project has been successfully demonstrated and not before."

"AEC and DOD have invested $195 million during a 7-year research and development program," he said.

Senate Votes NASA $5.246 Billion

Fulbright amendment would have cut lunar program by 10%; action indicates some trimming likely in appropriations bill

by Heather M. David

THE SENATE has voted authorizations for the National Aeronautics and Space Administration of $5.246 billion, less than 1.1% under the Administration request. Final vote on the bill was 78-3.

The agency, however, narrowly missed being slashed 10% in the entire *Apollo* program, a move which would have reduced the entire budget by almost $268 million. The amendment, offered by Sen. J. William Fulbright (D-Ark.), was defeated by only four votes, 42-38. (See roll call below).

The move recalled a similar amendment offered by Fulbright last year, when his motion to cut the NASA budget by $500 million was defeated by a similarly small margin. Fulbright's opposition, he said, was motivated by the fact that the Senate severely slashed the foreign aid bill last year, which he deemed far more important than the NASA funds. The Arkansas senator is chairman of the Senate Foreign Relations Committee.

● **Final action soon**—The closeness of the vote indicated that the NASA bill will receive some trimming from economy and election-minded senators in the actual appropriations vote. The Senate Independent Offices subcommittee is expected to consider the measure shortly.

In arguing for the cut on the Senate floor, Fulbright said that he felt it was a "question of priorities and nothing more." He asked that the country re-evaluate the goal of landing a man on the Moon in this decade. Fulbright labeled "contradictory" the fact that NASA administrator James E. Webb has said that it will cost the country approximately a billion dollars extra each year the program is delayed.

He said that this high figure is "utterly inconsistent" with the fact that Webb has then tried to downgrade the significance of the *Apollo* program in the total space effort.

The Arkansas senator warned the Senate that "this is the last opportunity to slow this down." He indicated that as the measure is passed this year, "We will have to say that we are committed to putting a man on the Moon by 1970." He called for attaining other goals—in education, exploring the ocean, and foreign aid before devoting large funds to space programs.

● **Anderson rebuttal**—Sen. Clinton P. Anderson (D-N.M.), chairman of the Senate Space Committee, pointed out that the U.S. had planned long ago for the Moon program. He said that President Eisenhower had a Moon program planned that would have involved landing on the Moon in 1975, at a cost of some $38 billion.

Sen. Wayne Morse (D-Ore.) rose to support the Fulbright amendment, and was, with Fulbright and Sen. Paul Douglas (D-Ill.), one of the three senators voting against the NASA authorization itself.

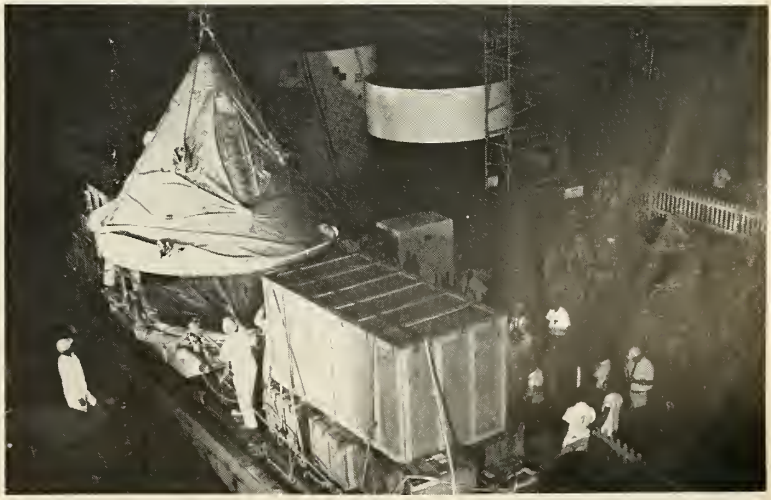
It was Morse's action that brought the NASA bill back into debate, after it had been speedily passed by the Senate on the first Monday after the end of the Civil Rights debate. Morse at that time charged that those opposed to the bill had not had an opportunity to state their views, and had in fact not even been present for the first voice vote.

Supporters of the NASA bill, led by Sens. Anderson and Stuart Symington (D-Mo.), lauded the effect the space program has had in the employment of scientific and engineering talent, on education and on the standard of living. Symington also quoted Gen. Thomas W. White, former Air Force Chief of Staff, who once said that in tomorrow's world, "he who controls space controls the world."

● **Unfinished business**—The Senate bill now provides $4.354 billion for research and development, $262.8 million for construction of facilities, and $629.2 for administrative operations.

Items of disagreement that must be worked out in conference with members of the House Science and Astronautics Committee are: Advanced missions, geophysics and astronomy, lunar and planetary exploration, tracking and data acquisition, Ames Research Center, John F. Kennedy Space Center, Manned Spacecraft Center, Marshall Space Flight Center, Michoud Plant, Mississippi Test facility, and other various construction locations, and administrative operations. ■

AS THE SENATE was voting authorization for a NASA bill which narrowly escaped a 10% cut, Apollo hardware was arriving at Cape Kennedy. Foreground, boilerplate command module, with service module and adapter in background.



Candid admission . . .

Air Force, NASA at Odds Over MOL Tracking Requirements

by James Trainor

CONGRESS will have to "crack some heads together" if NASA and the Defense Dept. are ever to reach agreement on the tracking requirements for the Air Force *Manned Orbiting Laboratory*, an Air Force general intimately connected with the program has told MISSILES AND ROCKETS. "It's the *Apollo* ships thing all over again," he said.

"Nobody likes to give up his empire," the general candidly admitted, "and both sides have set their feet and refuse to budge. The Congress will have to withhold funds as they did with the *Apollo* tracking ships before we'll reach any agreement."

Basically, he explained, the Air Force feels that it can meet its tracking requirements for *MOL* by the addition of "a few" additional tracking stations to its already extensive satellite-tracking network—at far less cost than if it incorporated its program with NASA's in a joint manned satellite network. A proposal to this effect will be made to the Defense Dept., he affirmed.

● **Equipment incompatibility**—Another bothersome point for both the Air Force and NASA is the frequency incompatibility between Air Force equipment and *Apollo* and *Gemini* systems. This is not an insurmountable problem, but one that both agencies have identified as requiring further study.

In March, Defense Research and Engineering officials told M/R they expected to complete their first estimate of *MOL* tracking requirements by the middle of May. When M/R recently tried to check the statements made in March by DDR&E it was told that there was nothing new to add and that the requirements study was not finished.

While no *MOL* tracking requirements agreement has been reached, the Air Force's National Range Division and NASA have established five working panels "to look for further economies" in areas where DOD and NASA requirements overlap.

These panels are studying: South African tracking facilities; the compatibility of S-band equipment used by the Sunnyvale, Calif., Satellite Control Facility and NASA; network design; instrumentation and, finally, a "super panel" to develop policies and procedures for all new programs in both DOD and NASA.

● **Apollo ships problem**—Last September, the House and Senate ordered DOD and NASA to develop a plan for a joint fleet of tracking vessels by January. Although authorizing the tracking ship funds in the FY '64 budget, the Congress told NASA not to commit them until a study of the joint needs had been completed and an interagency agreement reached. With this considerable spur, an agreement was reached and initialed by DOD-NASA last Nov. 22.

The agreement called for DOD management of the fleet, with actual operation by the Military Sea Transportation Service. Three new ships are to be outfitted and two modified to meet *Apollo* requirements. NASA is to provide the performance specifications for the instrumentation and special-purpose *Apollo* equipment.

Mobile instrumentation resources for *Apollo* then will total 14 ships and 19 aircraft. How much and to what extent these resources will have to be augmented for *MOL*—scheduled to fly during the same time period as *Apollo*—is still a moot question and one that may only be answered by Congressional intervention. ■



First Details on Martin RENE

THE MARTIN CO. last week revealed details of its Rocket Engine Nozzle Ejector (RENE), developed over the last three years at the Denver Div. System augments the thrust of conventional rockets in the atmosphere by mixing air with the exhaust flow. Using a simple, lightweight geometry with no moving parts, RENE can increase thrust of large engines by 100%. The concept is being tested at The Air Force's Arnold Engineering Development Center with a NASA rocket engine.

Fairchild Reveals Republic Stock Buy

Market observers expect Fairchild offer of merger proposal; little chance given any Republic effort to block move

FAIRCHILD STRATOS Corp. moved into the open its program of mass purchase of stock of Republic Aviation Corp. with a recent announcement of acquisition of 430,000 shares of Republic's 2.83 million outstanding common shares.

The announcement ended months of conjecture on the part of Repuhlic, the financial world and industry on the cause of the unusually high stock activity.

Edward G. Uhl, president of Fairchild Stratos, and Sherman M. Fairchild, chairman of the board, revealed that they were continuing the purchase of Repuhlic stock, with an ultimate goal of 900,000 shares "if it can he done without affecting the market." Reason cited for the investment was "to work constructively with that company," and to develop a major aerospace unit on the East Coast.

Republic officials learned the identity of the huyer only 24 hours before the puhlic disclosure. The company is not considered to he in good financial condition and is expected to show a second quarter loss in addition to a first quarter loss this year. Last fall the company laid off some 9,000 employees and is now involved in a dispute with McDonnell Aircraft Corp. that could mean a possible gain or loss of $10.5 million.

In addition, Republic's chief military plane, the F-105 Thunderjet, is heing phased out of production hy the Dept. of Defense.

Industry observers have predicted a merger proposal on the part of Fairchild and helieve it would go through on Fairchild terms. The likelihood of Republic stockholders joining forces to defeat the move is considered virtually impossible. There is not believed to he any other large single hlock holding in the issue. Mundy I. Peale, Repuhlic president, reportedly holds some 9,000 shares and probahly represents the firm's largest single shareholder.

Causes behind the timing of the Fairchild announcement are not definitely known although there are several probahle reasons. Foremost is a ruling of the Securities and Exchange Commission requiring a declaration of any stock purchases exceeding 10% within a 40-day period. Other possible factors are the stock speculation that had huilt up, the puhlicity that the buying was getting and the chance that the identity would he uncovered hy reporters who had heen working on the story for months.

Fairchild's stock purchases, conducted over the past six months, were helieved to he made through the firm of Merrill, Lynch, Pierce, Fenner & Smith, whose size would hest he ahle to disguise the buyer's identity.

However, the phantom huying has not put Fairchild into the role of a raider. Repuhlic president Peale expressed his firm's "high regard" for Fairchild but added "we will have to explore thoroughly all aspects of the situation." A meeting of the heads of the two firms was scheduled soon after the announcement, hut no statements have resulted.

The leaders of Fairchild, whose corporate headquarters are located in Hagerstown, Md., claimed that their company and Repuhlic were not direct competitors, hut would he ahle to complement each other. "We are not out to tear their company apart," said Fairchild. He told interviewers he expected his firm to share in the management of Repuhlic and to be represented on its hoard of directors.

The Fairchild president noted that his firm has "always been in the transport airplane field" while Repuhlic is in the military bomber field. He also pointed out that Repuhlic had a suhstantial technical hackground in aircraft designed for vertical take-off and that Fairchild was now in the helicopter field through a recent acquisition of Hiller Aircraft Corp.

Although Republic's consolidated sales rose 22% last year to $361.9 million, its order hacklog on Dec. 31, 1963, was down $270 million from $570 million a year earlier. It reported net income of $3.6 million for 1963, down from $5.9 million in 1962 and $10.9 million in 1961.

Fairchild Stratos had net income of $667,000 in the first quarter of this year. For 1963, its sales were $63.2 million, down from $70.5 million in 1962, and net income fell to $1.05 million from $3.05 million. ■

Eurospace Meeting Held in Rome

INCREASED COOPERATION hetween the U.S. and European missile/space industries is expected to result from the first high level conference of the Eurospace industrial organization held in Rome last week.

Some 150 top executives from hoth sides of the Atlantic met in closed sessions to discuss communications satellites and large project management. Only papers heard were from five Americans.

Both sides described the conference as a tremendous success, if only to show what a large communications gap exists hetween the two industrial communities. One European source said the conference served to demonstrate how far hehind Europe is in the management techniques of large projects.

Level of interest in the conference was demonstrated by the attendance. Among those on hand: the chairman and the president of Bolkow; president of Dornier; chairman of Compagnie Generale de Telegraphie; chairman of SEREB; vice president of Dassault; general manager of Thomson Houston; manager of Bristol Siddeley; president of Contraves; president of Fiat and numerous others of equal stature in Europe.

The initiative to have five Americans present papers came from the Europeans, who also invited U.S. firms to join Eurospace as associate memhers. Nine have done so in addition to one Israeli company and 15 European hanks.

Moon Map To Aid Apollo Astronauts

THE FIRST topographic map of the visible portion of the lunar surface has been published by the Corps of Engineers Army Map Service in support of NASA's lunar landing program. Covering 7-8 million sq. mi. of the Moon, the small scale (1:5,000,000) map is expected to be an important adjunct to *Apollo* program engineers and scientists in selecting potential landing sites for the Lunar Excursion Module.

To aid in geological studies of the Moon, the map has been layer-tinted to show relative altitudes of various lunar features. Shaded relief and contour-line versions of the map have also been prepared to show the texture and altitudes, respectively, of the lunar surface. Finally, three-dimensional plastic relief maps which dramatically illustrate the ruggedness of the Moon's surface, have been molded from the topographic maps.

In preparing the map, the Army officials working on the project were impressed, they said, with the magnitude of some lunar features. For example, the vertical distance from the lowest point on the Moon's surface to the highest is some 35,000 ft. Also, some of the geometrical patterns, such as seas, cover areas 800-900 sq. mi., while some rays are 1,000 mi. long. With respect to the *Apollo* mission, the most impressive aspect is the terrific ruggedness of the surface and therefore the potential danger in the LEM landing.

The Army Map Serevice is now preparing a smaller scale (1:1-2,000,000) map of the lunar surface on which they will be able to include more information for more detailed analysis of lunar geology and limitations on LEM landings.

● **Establishing a reference**—Since there is no familiar reference, such as sea level, upon which to base cartographic measurements, the Army selected a small crater near the center of the lunar disc and assigned the bottom of it an elevation of seven kilometers above the mean radius of the spheroid. All other elevations on the map were then referenced to this crater—called Mosting A.

In making the map, the Army culled some 3,000 photo pairs from holdings of the Lick and Pic du Midi observatories, and selected the best for detailed sterographic analysis. A closed-circuit TV system was used for photo-interpretation to see features on lunar photo negatives under varying conditions of light and shade.

A digital computer was used to insure maximum possible precision in determining relative heights and locations as well as to aid in the construction of exact projections of each of the lunar photographs.

The margin of error in the map, however, is 1,000 meters—primarily because of the distance involved between the Earth and the Moon and the librations of the Moon in its orbit.

The back of the map lists some 5,000 names of lunar features and gives the selenodetic reference of each.

● **Use at Langley**—NASA plans to apply the work of the Army Map Service to its Lunar Orbit and Landing Approach Simulator being built at Langley Research Center. The simulator includes a 20-ft.-dia. sphere, on which can be projected a representation of the lunar surface.

A 15 ft. by 40 ft. relief model of the center portion of the Moon will also be built. Both models can then be photographed to simulate various altitudes and the film projected onto a concave, aluminized screen for training in simulated lunar landings.

This will enable missions to be flown to simulate approaches to the Moon with the visible disc in view and the progressive narrowing of the astronauts' line of sight, first in the parking orbit and then as they begin their descent until the LEM's impact. ■

MARENTS Name Plagues Originators

AN UNFORTUNATE DESIGNATION for an Air Force scientific satellite is causing considerable consternation to its originators. Several weeks ago, it was revealed that Northrop Corp.'s Space Laboratories had been awarded a contract for *MARENTS—Modified Advanced Research Environmental Test Satellite.*

Immediately, the trade press and several industrial contractors assumed that this program was the same as the Advanced Research Projects Agency project begun in 1960 and continually plagued by booster slippages. In fact, the *MARENTS* program is currently a one-shot scientific experiment that will use only the *ARENTS* spacecraft shell.

The experiment to be carried in the *ARENTS* spacecraft will be an energetic particles payload and is being conducted by the Cambridge Research Laboratory. It will be launched as a secondary payload on one of the *Titan III* development flights.

"What Northrop is doing," an Air Force official explains, "is stripping out the insides of the *ARENTS* spacecraft and putting our experiment in." The contract, he estimates, will run 6-9 months and will cost approximately $725,000.

Meanwhile, Defense officials confirmed that the *ARENTS* program has been cancelled. General Dynamics/Astronautics had delivered three spacecraft, and these, in the interest of economy, will be used as carriers for scientific experiments.

ARENTS had originally been intended to provide information on radiation levels and spacecraft performance at orbital altitudes of 22,300 miles. This information was to be used in the *Vela-Hotel* program. Slippage in the *Atlas-Centaur* launch vehicle program precluded launching the satellies and eventually the program was discontinued.

Air Force officials are contemplating a change of name for the *MARENTS* satellite "to get away from the association with *ARENTS*." This is a continuation of military space environment experiments under the auspices of the Office of Aerospace Research and CRL.

AIAA Expects 5,000 Registrants, 75 Exhibitors at First Meeting

ONE OF THE LARGEST aerospace meetings ever to convene in the U.S. opened today with the first annual convention of the American Institute of Aeronautics and Astronautics in Washington, D.C.

Nearly 5,000 registrants are expected during the June 29-July 2 meeting, AIAA officials told MISSILES AND ROCKETS last week. The total program will include more than 350 technical papers, 34 "state-of-the-art survey papers" covering major fields within the aerospace industry, exhibits by 75 manufacturers plus NASA/military displays, and the lecture-demonstrations presented by a large number of the exhibiting firms.

Six nationally known aerospace leaders will speak: Dr. Hugh L. Dryden, NASA deputy administrator and this year's winner of the AIAA Hill Award, will be principal banquet speaker; Prof. Courtland D. Perkins, AIAA president; Dr. Eugene G. Fubini, assistant secretary of defense-deputy director, directorate of Defense Research & Engineering; Dr. Robert C. Seamans, Jr., NASA associate administrator; Najeeb Halaby, FAA administrator; and Dr. Arthur R. Kantrowitz, director of the Avco-Everett Research Laboratories. Dr. Kantrowitz will deliver a lecture memorializing the contributions of Dr. Theodore von Karman to the development of flight science.



APOLLO guidance computer (foreground), will be described in Raytheon presentation.

- **Lecture-demonstrations**—First broad use of the lecture-demonstration technique by conference exhibitors occurred at the American Rocket Society's 17th annual meeting at Los Angeles in November, 1962. (The merger of ARS and the Institute of Aeronautical Sciences shortly thereafter resulted in the formation of the AIAA).

Based on the success of such company-sponsored programs, presented concurrently with the more formal technical sessions elsewhere at the meeting, AIAA has enlarged the number of exhibit-hall presentations, but will control their use through an overall schedule. As recently as last month, however, AIAA official publications showed an expected program of only 100 exhibitor lectures.

With the now-scheduled 250 lectures, some 60 to 70 will have to be held each day. These will be presented at half-hour intervals all day, each day, from 9:15 to 5:00 p.m.

- **Technical sessions**—The technical sessions this year have been divided into two categories—survey and synoptic. Survey sessions will encompass state-of-the-art reviews of the advances and present condition of each of 34 major aerospace disciplines.

Simultaneously with the survey presentations each day, eight separate sessions will be offered in which more than 350 ten-minute synoptic papers will be read. These will relate recent advances in 32 aerospace fields of interest in summary fashion. ■

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Technical Countdown

ELECTRONICS

Z-Trace Explained?

An unexpected result of a high-altitude sounding-rocket probe last April was the verification of the existence of the "Z-trace" in the ionosphere. From their analysis of measurements obtained from the Wallops Island launch, University of Illinois engineers also report they found sufficient evidence to support a theory explaining the trace. The so-called Z-trace involves radio signals that appear to pass through the ionosphere hut instead are companion signals created hy a coupling effect. The phenomenom, said University officials, might he likened to the coupling action that occurs in a transformer wherein current is generated in one coil by passing a current through another not electrically connected to the first.

Troposcatter Competition To Be Held

A RACEP tropospheric-scatter communications system, developed by the Martin Co.'s Orlando Div., will compete with more conventional troposcatter systems for eventual employment on the Atlantic Missile Range hetween Grand Turk Island and Puerto Rico. RACEP, a Martin-patented technique, uses time-frequency coded radio pulses rather than conventional FM techniques. In the tests, conducted hy USAF's Rome Air Development Center, three systems will be operated side-by-side for two months. Both digital-data and voice transmissions will he employed in the test operation.

Random Disturbance Reduced in Systems

Automatic controls will be able to more effectively cope with random disturhances hecause of mathematical formulas solved by Prof. Rufus Oldenhurger of the School of Mechanical Engineering, Purdue University, Lafayette, Ind. The formulas may make possihle automatic control systems to perdict random disturbances and take action before the event. The formulas can he used to advise the system on how to adjust itself while a disturhance is curbing the system, and also as an approach to regaining optimization if there is a performance cut. Sudden changes in temperature and system power input are among the major random error inputs. Oldenburger told a recent Joint Automatic Control Conference that he has reduced an 8° F error to a 1° F error and also reduced hy 66% the error incurred in another instance where the disturhance was just starting.

PROPULSION

New Solid Fuel Evaluated by Army

A new fuel for high-energy rocket propellants was described at the recent Army Science Conference (See Page 26) held at West Point. Designated as Olane 58 or Dow 1451, the composition is classified, hut grew out of work on high-energy fuels and oxidizers sponsored hy the Advanced Research Projects Agency of DDR&E. Dow Chemical Corp. is currently working up a sales effort for the material. Theoretical calculations indicate that an improvement in specific impulse may he ohtained in present propellant systems hy using the composition. While not specifically stated in the abstract of the classified paper presented by Huskins and Howard of the Army Missile Command, the material is prohahly aimed at solids.

Titan III-C Solid Passes Impact Hazard Tests

A 10 x 10-ft. center segment of the *Titan III-C* 120-in. solid hooster hit an armored concrete abutment without detonating in the last of a series of hazard classification tests at the Naval Ordnance Test Station, China Lake, Calif. Equipped with forward and aft closures and including a nozzle, the rocket segment reached a speed of 435 mph under its own power and impacted with more than 80,000 lbs. of unburned propellant in the case. The total propellant load exceeded 92,000 lbs. NOTS Test Director Hal Ritchie said the rocket was three times larger than anything previously tested on the supersonic track. The United Technology Center rocket simply broke up without ignition of the unburned propellant. The test case had been loaded and fired twice before the impact test.

Be for Al in Surveyor Solid Retros

Beryllium powder will be suhstituted for aluminum in a planned feasibility test firing for *Surveyor* main retrorocket engines. Jet Propulsion Lahoratory is calling a hidders conference for the first week in July to set up the test. The beryllium powder will increase the specific impulse of the solid-propellant composition over that achieved with aluminum, and JPL planners hope this will be enough to handle the increased weight of the probe. The weight gains have been in the radar altimeter and doppler velocity sensor. There is also a contribution from the mid-course correction requirement. The total weight increase effect is cutting into the scientific payload.

MATERIALS

Refractory Ultrasonic Welds Improved

A system providing incremental changes in ultrasonic power and clamping force during a single weld cycle is said to significantly improve the weld strength in refractory metals and high-temperature alloys. Called "Power Force Programming", the initial work was sponsored by the Navy and a report is available from the Commerce Dept.'s Office of Technical Services for $2.50 under the order number AD 427 997. Researchers provided for 10 incremental power values and 10 incremental force values within a single weld cycle and incorporated the system in an existing 4 kw ultrasonic spot-type welder.

SPACE MEDICINE

Closed Water System in Development

A closed ecological life-support system, being huilt under NASA contract by General Dynamics/Astronautics, would enable an initial supply of 29 gallons of water to serve the needs of a four-man space station crew for a year. The water regeneration equipment, one of many subsystems in the complete life-support system, would recover and purify water from several sources, including urine and excess moisture in the cabin air. The system, when completed, will undergo both manned and unmanned tests in a mockup space station to be huilt at GD/A. The program is under the direction of NASA's Office of Advanced Research and Technology.

Spacecraft Protection Needs Get Increased Douglas R&D Attention

Firm foresees $20 million worth of business by 1969 in shrouds, interstage structures and separation systems with advent of large unmanned craft in NASA, DOD plans

by Willard E. Wilks

TULSA, OKLA.—Douglas Aircraft Co.'s Tulsa division is devoting considerable research and development to spacecraft shrouds, interstage structures and separation systems, projecting a continuing growth in this area as NASA and the military develop more and larger unmanned systems.

The division expects this business to total $2 million in FY 1964, and produce about $20 million for Douglas/Tulsa between now and 1969.

Latest development is a linear piston and cylinder invention for separating clamshell-type shrouds that protect the spacecraft from aerodynamic heating during ascent. This eliminates the need for two spring thrusters weighing 15-20 lbs., and located internally on each side of the shroud to push the clamshells apart. Disposing of the thrusters significantly increases the working spacecraft envelope inside the shroud. All structure inside the fairing that cuts into the payload envelope—including pivot brackets, bands, explosive bolts—is eliminated.

Contamination and fragmentation also are eliminated.

The linear piston-cylinder fairing-separation device is contained entirely in a channel around the clamshell edges in an arrangement similar to the well-known tongue-and-groove design, the groove being the cylinder and the tongue a strip of metal that is locked into the groove but free to rise high enough to cut shear pins holding the shell halves together. Ignition of a mild detonating fuse under the linear piston drives it against the shear pins.

Advantage of this technique over other pyrotechnic devices is that it solves the contamination problem common to explosive devices. Smoke and debris are contained within the cylinder where they cannot harm solar cells or other spacecraft parts.

● **Broad application**—The division began work in the front-end hardware area in 1957 with the Air Force *Able II* project and has continued with such programs as *Alouette, FIRE, EOGO, Shotput, Gemini, Nimbus, A-12, Echo, Explorer* series, *Ariel 1, Relay 1, Syncom, IMP, Telstar, OSO, Transit, Tiros,* and *Delta.* It is designing interstage adapters for *Saturn* S-IV and S-IVB and proposing on shrouds that will house unmanned payloads on *Titan III, Centaur* and the *Saturn* vehicles.

All spacecraft fairings produced by the division use identical separation techniques and possess very similar physical characteristics, using phenolic glass fiber construction.

Identical separation hardware is used for each diameter of spacecraft fairing.

"This grouping allows each type of shroud to rely upon the supporting family of components to assure a highly reliable, successful program," the division points out.

● **Clamshell is basic design**—All shrouds employ the clamshell design in which fairings are separated along a longitudinal plane into two halves, which are jettisoned by the action of explosive bolt-released springs, insuring positive separation and precluding collision of either half with the launch vehicle.

This design is opposed to the one-piece shroud, which must be ejected over the nose of the spacecraft without striking any portion of the payload.

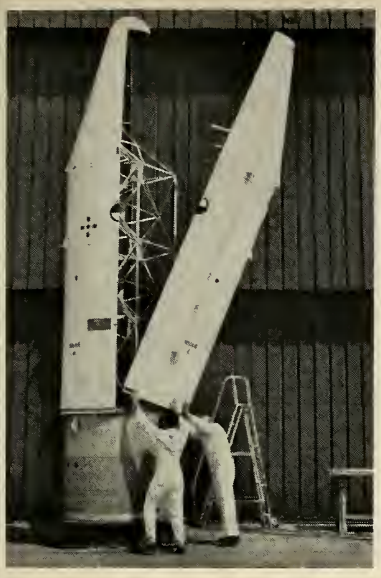
H. E. Felix, director of product development in the Missiles and Space Systems division, Tulsa, says the division believes this is the simplest way of "getting rid" of a shroud, and all of the division's advanced investigation employs this design.

Ranger and *Mariner* spacecraft have employed the one-piece shroud design, having to pitch slightly to avoid collision with the shroud after it is ejected.

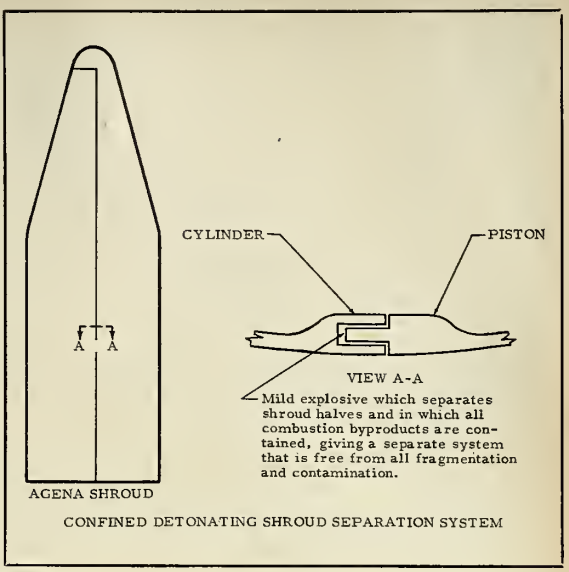
Basic types of shrouds produced at Tulsa include the *Delta* low-drag, *Delta* extended low-drag, *Delta* bulbous, *Delta* extended bulbous, *Agena* short and *Agena* long.

The *Delta* low-drag fairing has an outside diameter of 33 in., inside diameter of 29 in. tapering to 10 in., is 124 in. long, and weighs 154 lbs. Length is stretched to 156 in. in the *Delta* extended low-drag configuration, with weight going to 192 lbs.

The *Delta* bulbous shroud is designed to accommodate a payload of somewhat larger diameter with a fairing of the same diameter at the base. With an outside diameter extending to 49 in. at its widest point, the bulbous fairings will carry a payload up to 44 in. wide. The *Delta* bulbous shroud



LEFT: Medium-Altitude Communications Satellite dispenser shown within Agena long fairing. RIGHT: Diagram of Agena long fairing shroud separation system.



is 115 in. long and weighs 192 lbs. The proposed bulbous extended shroud would be 169 in. to allow a larger payload area.

The *Agena* fairings have an outside diameter of 65 in., with a payload area 57 in. in diameter tapering to 17 in. They are 117 and 224 in. long. The *Agena* short fairing weighs 265 lbs.; the long one, 535 lbs.

● **Delta shroud use**—The *Delta* shrouds will protect such spacecraft as *Relay A-16* and *17, Syncom A-27, S-3C,* and *Tiros H* and *J.*

The *Agena* short fairing will protect the *Gemini* docking adapter, and *FIRE* re-entry packages, while the long version was selected for the proposed multiple communications satellite project.

Any intermediate length spacecraft can be accommodated in the Douglas shrouds by removal of a portion of the cylindrical section without affecting flight qualifications of the fairings.

To demonstrate satisfactory separation of shrouds, separation tests are conducted during the developmental stage and on the final configuration. Tests are conducted under both altitude and ambient conditions. A large altitude chamber provides controlled environmental conditions to 120,000 ft.

In addition to its altitude chamber, the Tulsa division has a 60-ft.-high zero-g tower that is the only one of its kind in the U.S. It is used to perform tests under zero-g and various simulated altitude conditions. It can simulate altitudes to 150,000 ft., and with additional equipment can go to 300,000 ft.

The recently-completed zero-g tower will accommodate test specimens up to 7 ft. in diameter and is equipped with an optical system that determines, with respect to time, angular displacement of test specimens during free fall within 0.002 degree and 0.001 sec.

● **Interstage effort**—In its interstage work, the division provides *Delta* interstage structures that serve as the transition structure between the *Thor* and the *Delta* second stage. The upper stages are attached at four hard points by explosive bolts. When fired, they allow the spring-loaded trusswork to open, freeing the second stage.

The second-to-third stage interstage structure consists of a spin table and four petal-like hinged magnesium doors. Spinning is accomplished by a number of small solid popellant motors of selected total impulse.

The division's spinning and nonspinning separation and deployment systems include multiple satellite deployment hardware. It fabricated the prototype dispenser for the *Medium Altitude Communication Satellite* (*MACS*) program. The dispenser, made of aluminum tubing, would carry seven satellites, six on a side and one on top. It would remain attached to the *Agena* while deploying the satellites, being protected by an *Agena* fairing during exit.

● **Working on Rebound**—The division also has developed the deployment techniques for the *Rebound* multiple-satellite deployment system. Such a system must place each satellite in position with the proper initial conditions of attitude, rate-of-change of attitude, and velocity.

To do this with a high degree of reliability, the number of sequenced events and their complexity is minimized. Random distribution can be achieved by a small differential velocity between satellites. Separation rate between satellites at a typical orbital altitude is about 0.28 degrees/fps/day. Thus, a dispersion time of about two weeks requires a relative separation velocity of 15 fps.

The deployment techniques developed for *Rebound* include springs and explosively operated annual pistons to satisfy these requirements. The deployment system carries three satellites.

The multiple satellite deployment system developed for the *Alouette* satellite carries two vehicles, one atop the other. The lower spacecraft sits on a spin table and is enclosed by stucture that supports the upper satellite. After ejection of the upper payload, the support structure is ejected, leaving the lower spacecraft clear for ejection. At ejection of each spacecraft, the spin table is spun up to the desired speed.

On *Delta* vehicles, Douglas-built spin tables allow rotation of the third-stage assembly before separation. The table is restrained during the first- and second-stage powered flight by an aluminum shear pin, which is sheared when the spin rockets are fired. The desired spin rate is achieved at spin-rocket burnout.

Small solid propellant spin rockets are mounted on the table with their thrust axes tangent to the table's circle of rotation. The number employed depends on the roll moment of inertia of the spinning mass and on the desired spin rate.

Two sizes of spin rockets are available and can be used interchangeably in any combination to deliver the desired rotational impulse. ■

Army Cites Re-entry Body Advances By Materials Research Agency

Technology 'fallout' from ABM work may include new warhead, decoy production methods; test of re-entry shapes may occur late this year

by Michael Getler

WEST POINT, N.Y.—Advancements in fabrication methods for re-entry vehicles destined for use in development of anti-missile radars may also provide new techniques for producers of warhead and decoy re-entry bodies.

Working under an Army Missile Command contract, believed to be part of ARPA's AMRAD (Anti-Missile Radar) Project, civilian scientists from the Army's Materials Research Agency in Watertown, Mass., report new shear-spinning techniques applicable to hemispherically shaped refractory metals and development of new variable-tension tape-wrapping fixtures for applying non-metallic material over a hemispherical metal substrate.

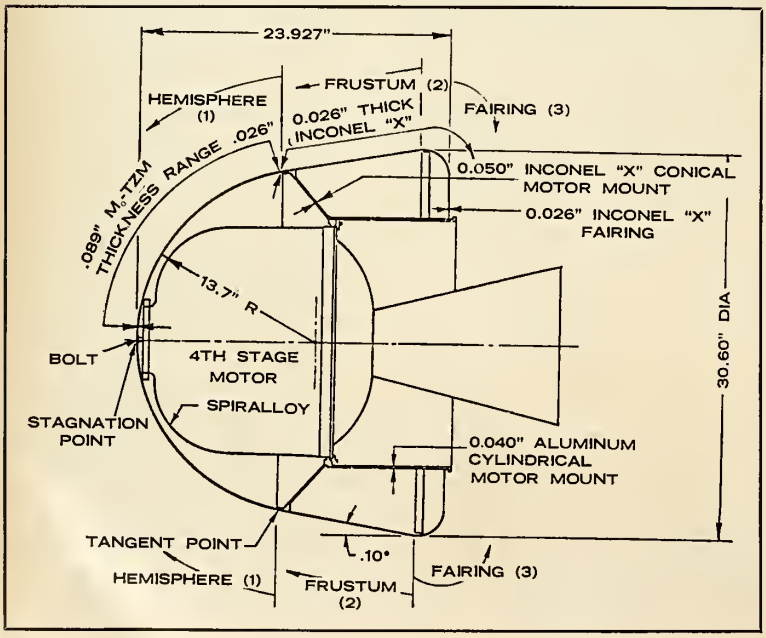
The Army report came at the three-day Army Science Conference held here last week. About 400 government and industry scientists attended the sessions, many of which were classified.

Scientists at Watertown have now completed ¼-scale metallic and non-metallic re-entry vehicles and have begun work on the full scale vehicles, which reportedly will be flight tested either late this year or early in 1965. The test vehicles will be lofted aboard a four-stage system, possibly the *Athena* booster (M/R, July 8, 1963, p. 18, Sept. 2, 1963, p. 10) using the first two stages to achieve maximum altitude and the upper two stages to propel the shape Earthward at re-entry velocities of about 25,000 fps.

Actual radar material identification measurements and on-board telemetry readings will be made from initial re-entry altitude of about 300,000 ft. to about 100,000 ft., corresponding to an elapsed time of 11-40 seconds depending upon the particular re-entry body and load carried. Vehicle pitch, yaw, deceleration, radar cross-section and ionization pattern measurements will be taken.

● **Seeks signatures**—The intent of the program is to develop basic radar signatures on both metallic and non-metallic objects (which produce different ionization patterns) that can be compared to a known set of parameters. With the re-entry shape materials known, and by instrumenting the payload to provide correlated telemetry data to relate to radar profiles taken at specific points and speeds during the re-entry, radar calibration can be accomplished. In general, most warhead and decoy designs are believed to be of the non-metallic type. Inclusion of the straight metallic design is basically aimed at developing profiles on other space debris accompanying a missile

METALLIC RE-ENTRY VEHICLE



that might also complicate the radar discrimination problem.

Though measurement of the wavelength of the ionization pattern can normally separate the metallic from the non-metallic vehicle, scientists point out that altering the wavelength by some means aboard the vehicle could possibly fool the radar, and that re-entry speed and angle are also of major concern in attempting to develop ABM launch decisions.

For the metallic heat-sink type of re-entry vehicle produced at Watertown, the molybdenum alloy Mo-TZM was chosen for the hemispherical portion of the vehicle, which absorbs the re-entry heat generated. Watertown scientists told MISSILES AND ROCKETS that beryllium would have been the optimum material, but that fabricating the required shape in the time alloted ruled against its use. Inconel "X" was chosen for the frustrum and fairing portions of the vehicle that follow the Mo-TZM tip.

A phenolic-impregnated glass fiber was selected for the entire outer skin material of the non-metallic ablative-type vehicle. The specific combination, according to the scientists, is type 128, 111 finish, glass fiber cloth impregnated with type Conlon 505 phenolic resin. The substrate for the glass fiber covering is 5052 aluminum.

● **Shear-spinning**—The shear-spinning technique was used with the Mo-TZM, Inconel "X," and the 5052 Aluminum. The metallic Inconel "X" frustrum, the Army reports, was first rolled into the required shape and finally shear-spun to size. Scientists point out that shear-spinning these materials required markedly different reduction ratios, numbers of passes to obtain the desired reductions, intermediate anneal cycles, roller settings, angles and temperatures.

The ablative vehicle skin was wrapped using 1- and 2-in.-wide glass fiber tape on a new fixture that reportedly incorporates integral devices for varying tension on the tape, for heating it, and for accommodating different width tape rolls.

Among other new development techniques in this area, the Army also reported use of electron beam welding to join the Mo-TZM hemisphere to the Inconel "X" frustrum.

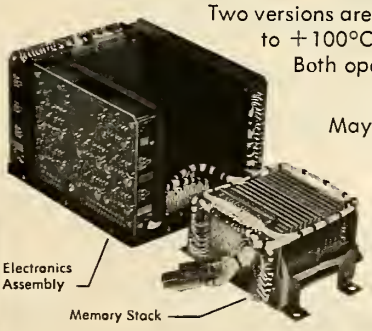
It was also disclosed at the conference that the Army has completed evaluations of an experimental model of a new $30-35 meteorological balloon capable of rapid ascents to altitudes in excess of 100,000 ft. The Army, this month, will begin buying service test models from the Kaysam Corp. of America, Paterson, N.J., for field models. The development has been sponsored by the Army's R&D operation at Ft. Monmouth. ■



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Portable EB Welding May Get Space Role

Hamilton Standard studies indicate hand gun approach feasible; power pack size reduction next step

by John F. Judge

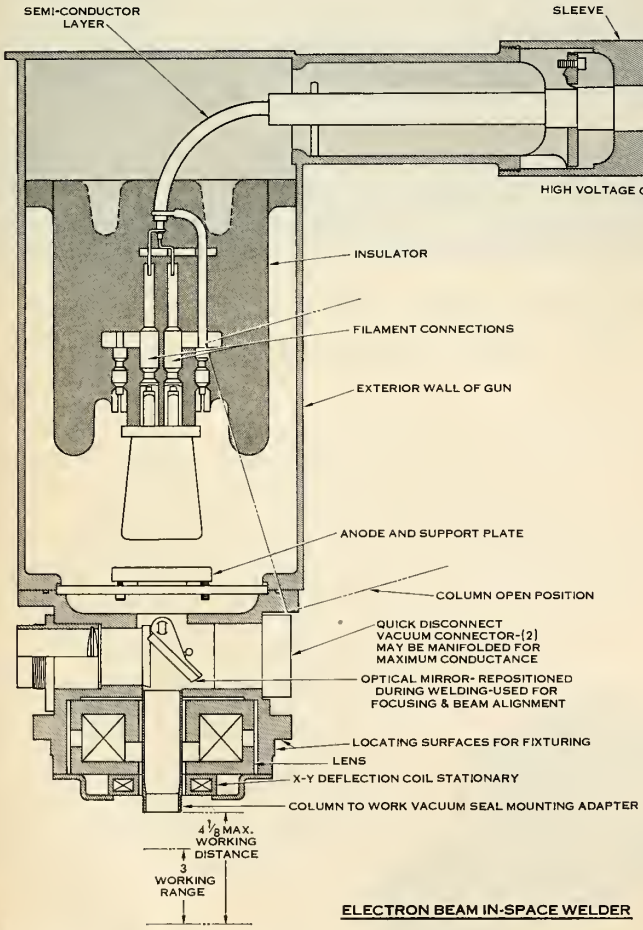


DIAGRAM OF Portable Electron Beam Welding Gun.

WINDSOR LOCKS, CONN.—Lightweight portable electron beam welding units are a strong contender for onboard fabrication and repair problems associated with long-term manned space stations.

Studies and experimental programs at Hamilton Standard Division, United Aircraft Corp., have demonstrated the feasibility of the approach. The entire effort is being funded by the Manufacturing Technology Division, Air Force Materials Lab, an arm of the Research and Technology Division.

A breadboard model has been built and Hamilton Standard engineers are well into the third and last phase of the contract. This involves checking out the prototype electron beam gun column and manipulation device in an instrumented ultra-high-vacuum chamber.

The basic problem behind the development program is in maintaining structural integrity and a habitable atmosphere in long-term, manned spacecraft. In addition, several of the approaches to near-future space stations call for some erection steps in space. The main task is in achieving a sound, hermetic seal.

There are many proposed schemes for in-space erection-unfolding panels, pressure plates, flange-bolt concepts, flange-explosive pin designs and other mechanical expansion innovations.

● **EBW on top**—Hamilton Standard specialists first considered all types of fusion welding before settling on electron beam techniques. A primary consideration is that the welding process must not exert an appreciable force on the workpiece. Since the work is to be done in space, any kind of force at all tends to provide thrust.

In addition, the power requirements are high in ordinary welding techniques. Thin structures tend to warp unless the heat zone is extremely narrow. Electron beam welding (EBW) characteristically puts the heat in the weld and nowhere else.

The weld speed must be as fast as possible, since it probably will be done in the hostile space environment and the less time a man is exposed, the greater the safety factor. In this vein, EBW does not involve complex pre- and post-weld operations.

Finally, cost analysis approaches again pointed to EBW systems.

Hamilton Standard is one of the leading manufacturers of EBW equipment. This background was brought to bear on the problem of reducing the size and weight of EBW equipment.

The first advantageous characteristic of space structures is that they themselves tend to be thin. The maximum weld thickness needed would run about ⅛ in., with the greater demand for smaller cross sections. Conventional

welding is often for larger sections and the equipment—even EBW—is general purpose.

● **Coping with voltage**—Hamilton Standard engineers compromised on the voltage question. A high voltage is most efficient with EBW with respect to power consumption and high voltages are necessary for penetration.

But too high a voltage leads to generation of X-rays, introducing a shielding problem. A maximum accelerating potential of 80 kv and a 12.5-milliampere current are considered to be adequate for more than 90% of the possible weld jobs.

This capacity is sufficient to provide a 0.150 in. depth of penetration in aluminum at 15 in./min. Based on previous experience, comparable or greater penetrations can be achieved for steels and titanium.

● **System requirements**—The general system requirements include an ability to weld 0.125 in. aluminum in butt, lap and "T" welds. Maximum penetration is set at 15 in./min., but speeds up to 60 in./min. are possible.

The duty cycle is modified pulse—5 minutes on, 5 minutes off for a 50% maximum. Cooling is achieved by radiation and inherent component heat-sink capability.

All systems considered by Hamilton Standard include both a battery pack for true portable operation and an inverter to permit use of spacecraft onboard power systems.

The total system weight for a prototype unit is estimated to be 347 lbs. including 200 ft. of low-voltage supply cables for direct use with on-board power. The gun itself is anticipated to have an overall volume equal to a cylinder 18 in. long with a maximum diameter of 9 in. Its weight, including lead shielding for attenuated X-ray radiation, is pegged at less than 120 lbs.

A 0.99 probability of completing a 2-hour in-space welding job was established as the minimum requirement for the system.

● **Lens considerations**—The anticipated unit will use a 32-mm.-deep Steigerwald gun assembly with some added design modifications to afford penetration. The significant point with the new system is the shortened location of the magnetic lens system.

The lens design has two possible transmission bore diameters—1.6 or 1 in. The larger diameter affords less spherical aberration of the electron beam.

Alignment of the beam with the optical column is accomplished by locating the focusing coil system rather than the upper portion of the gun column.

A bellows seal design is being perfected for welding in a pressurized environment. A vacuum is necessary for EBW. It can be created within a chamber formed by the bellows seal around the workpiece. There is some thought being given to providing a fiber-optic viewing system for the operator to aid in focusing.

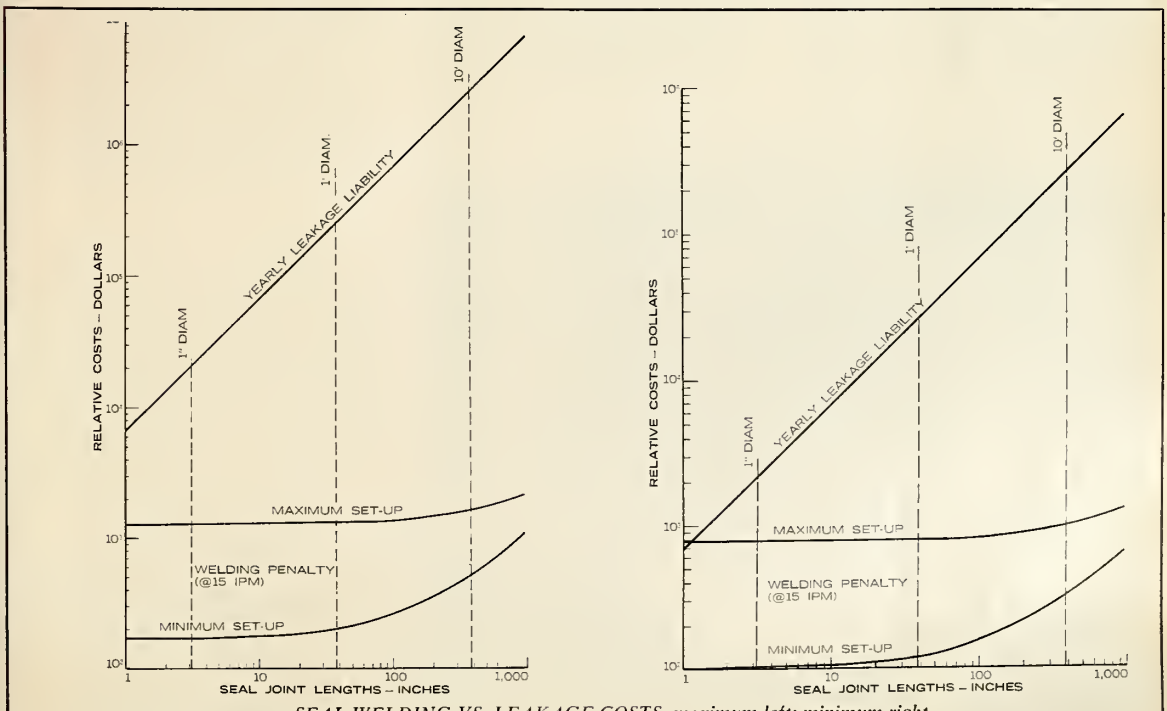
Special fixtures for handling small circular and large internal circumferential welds are being developed as part of the program.

The breadboard system in being at Hamilton Standard is not weight- or size-optimized. The equipment is designed to demonstrate the essential points of the overall portable EBW concept.

● **System components**—The man would carry both the gun and a power-conversion system. The power-conversion package would operate from either batteries or on-board sources. The same package would house the high-voltage supply. This would be the largest element in the system.

The control console would be the third section of the high-voltage power supply. The console eventually will house the necessary controls to adjust the beam accelerating potential, beam current, beam focus, beam deflection and also gun travel or welding speed. In the present lab layout, a much more simplified system is being used. None of the components has as yet been engineered for flightweight use.

The progress to date has not indicated any major problems in adapting EBW to space applications. The graphs illustrating the effect of various leak rates on long-term vehicles underlines the crucial nature of effective hermetic seals and the ability to both create and repair them. ■



SEAL WELDING VS. LEAKAGE COSTS, maximum left; minimum right.

New Inertial Sensors Show Promise

Electrostatic devices could offer cheaper, less complex accelerometers, gyros; roles seen in navigation and gravity gradient work

by William Beller

A PRACTICAL WAY to get cheap but highly accurate sensors for inertial instruments such as accelerometers and gyroscopes was revealed today at the start of the first annual meeting of the American Institute of Aeronautics and Astronautics in Washington, D.C.

The technique could easily lead to an all-electronic guidance system with no moving mechanical parts.

The basic work for this sensor development was done before 1910 by physicists Millikan and Ehrenhaft, when they were able to suspend in a homogeneous electric field small charged particles and determine the amount of charge on them.

Extending this idea to practical instruments, researchers Clifford D. Strang and Robert A. Cunningham at Martin Orlando Research Center have shown they can suspend macroscopic particles in an electric field, introduce some external perturbing force such as acceleration, and come out with a reading of the amount of the acceleration.

This ability alone, although said to be creditable, would not be attracting much attention were it not that compared with other inertial instruments in certain missile applications, "an instrument based on the technique could be built for about one-fourth the cost, and one-third the weight and size." This is the promise Martin sees, MISSILES AND ROCKETS learned from W. M. Furlow, manager of the company's physical sciences laboratory in Orlando, Fla. It is also one of the reasons the Navy is sponsoring the Martin work.

● **For missile platforms**—The Bureau of Naval Weapons, where Martin has held its contract on its sensor development since the beginning of the year, confirmed Furlow's appraisal by noting, "(the sensor) has a high potential for an inexpensive missile inertial system." In this regard, the spokesman for the Navy pointed out DOD's cost-effectiveness program: "you can always get a pretty accurate gyro for a million dollars, but the trick is to do the same job for, say, $500."

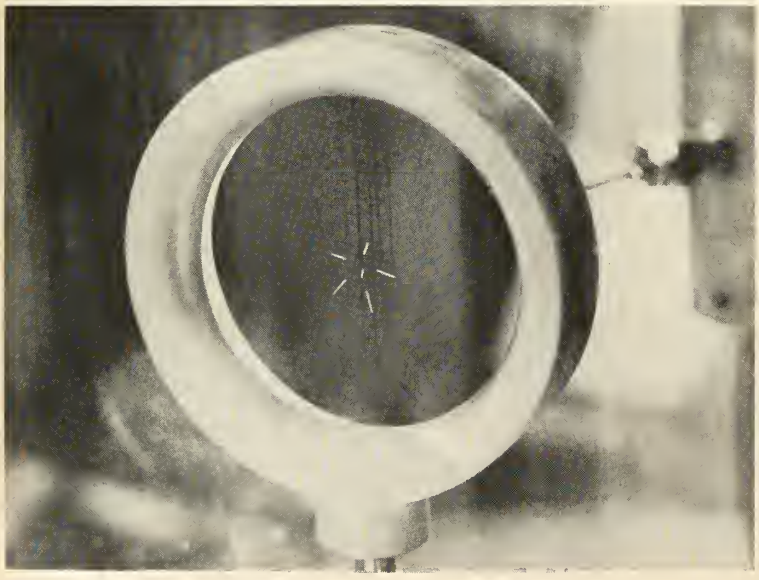
The Navy spokesman noted, also, that the Martin program is one of several promising programs going on under service sponsorship in unconventional inertial techniques, unconventional sensors and unconventional accelerometers. The immediate application is in missile guidance systems.

Among the programs he listed under contract is the nuclear magnetic resonance gyro that Republic Aviation is working on and the vortex gyro contract with Development Laboratories, Los Angeles. (For a general survey of new developments in the gyro field, see MISSILES AND ROCKETS, Oct. 7, 1963, p. 68.)

In addition to its use as a sensor in an accelerometer or gyro, Furlow sees an instrument built around electrically suspended particles used for gravity gradient measurements or gravity gradient space navigation. This would mean navigating a space vehicle from one point to another based on the known gravitational gradients. "With one of our research instruments, we can get a good stable measurement of gravity, but it would have to be improved over a period of time," says Furlow.

Although Martin has shown the feasibility of the "particle reference" technique for inertial sensing, Furlow says the company is holding back proclaiming development until it has an order-of-magnitude better precision in its laboratory devices. "Theory is fine and so are measurements, but we want to assure ourselves that what we have

TRACES OF PARTICLES vibrating in electric field illustrate principle of sensor.



in the lab is at least 10 times better than what we ever expect the shop to put out," says Furlow. He added that he expects development to begin toward the end of the year.

● **Theory into practice**—The basic idea is to suspend macroscopic particles —ranging in size from 2.5 to 250 microns—in an electric force field. Martin Orlando has been able to do this in a low-voltage field, a notable achievement since other known approaches with large masses require extremely high voltages.

Long-term stability tests on experimental devices are said to have yielded results "even better than present theory would indicate," sufficient, apparently, for a wide range of applications.

Typically, spherical charged particles are shot into an evacuated ring chamber containing an electrical force field put in by balancing electrodes. Some of the particles are captured and held in suspension in the field. These particles of known inertia tend to maintain their positions in space. But when an external perturbing force acts, such as acceleration, the displacement of the particles is observed and is a measure of the perturbing force itself.

The ring chamber is shown in a picture with this articles. The star-like "lines" in the center of the chamber are macroscopic particles in an oscillating electrostatic field.

The sensor can be used either open loop or closed loop. In other words, the suspended particles in an acceleration field can either be returned to the center of the chamber or not. In the open-loop system, the acceleration is measured by the displacement of the particles; in the closed-loop system, by the vector of the field force needed to return the particles to the center of the chamber.

Since the particles can move in any direction under the influence of an external perturbing force, it can sense acceleration in any direction. Therefore, a device based on this principle could replace the three accelerometers conventionally placed on a missile inertial platform. This is one of the reasons for Martin's claim of a possible "substantial" reduction in the cost of missile inertial elements.

In a suggested closed-loop design, a small projection lamp illuminates the particles. Their displacements are detected by optical pickups or photocells. The resulting optical error signals are then amplified to drive the servo system to continuously maintain the system at a null. The nulling voltages serve as the output signals.

● **Environmental immunity**—Martin engineers claim their tests show the particle reference device is virtually immune to external environment. Stability is "apparently unaffected by temperature extremes, vacuum or pressure, or even laboratory levels of nuclear radiation."

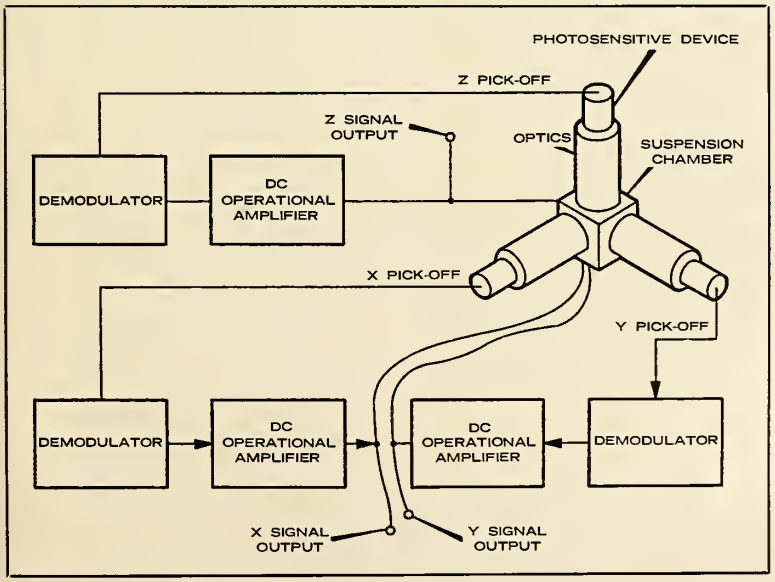
Tests also indicate "a major advantage in flexibility, since the range of the accelerometer can be adjusted to meet a wide variety of operational conditions." The scale factor of the basic unit, for instance, with minor modifications, can be set from 0.1 to 30 volts per g and the range extended to plus-or-minus 100 g or more.

At the high sensitivity level, the particle reference technique would be useful for gravity gradient work and navigation. Furthermore, in the extended g range, and because of the low-voltage gradient per unit acceleration input, the technique is applicable to the high-acceleration conditions of tactical and short-range missiles. Martin says that since the force-balance field can be controlled accurately and rapidly, it is possible to build extremely rugged systems with high reliability.

● **Varying the field**—When the particle reference technique is applied to a gravimeter, one idea is to impress a varying frequency on the suspended particles instead of servoing to a null balance with a voltage. Since the suspension stiffness in an electrical field is frequency dependent, the amplitude of the excursion of the oscillating particles would be a measure of the gravitational field. The frequencies used are in the audio range.

In applying the technique to a "gyroscope," Martin engineers impart angular momentum to a particle. In one approach described by the company, the charged particle is placed in a field shaped in a manner to cause the particle to rotate synchronously in a circular orbit with a predetermined center, radius and orbital velocity. The plane of the orbit is then used as an angular reference, which is monitored by optical or electrostatic pickups to provide an angular rate-sensing device.

Although Furlow claims that Martin has demonstrated only feasibility of the particle reference technique, he, at the same time, points to a variety of operating laboratory devices of a variety of configurations and modes of operation. He claims, too, that there are no theoretical roadblocks to the application of the techniques to practical instruments. Less conservative scientists see early development of the technique into operational hardware. ■





ABOVE: Experimental model of three-axis accelerometer.

LEFT: Particle sensor finds acceleration simultaneously in three planes.

RCA Unveils 'Stabilite' at AIAA

NASA, DOD both study use of new active three-axis satellite stabilization system based on 'wheel' technology

PRINCETON, N.J.—A new active three-axis satellite stabilization system developed here at RCA's Astro-Electronics Div. (*see cover*) is being actively studied by military and civilian space agencies for possible use in near-Earth meteorological, reconnaissance, biological, and radar-range calibration satellites.

It is being shown publicly for the first time at this week's meeting of the American Institute of Aeronautics and Astronautics in Washington.

The system is also likely to find its way into future RCA proposals in the areas of navigation, communication, and observatory-type satellites, and as a platform for space-based laser systems.

Called "Stabilite," the system builds heavily upon the *Tiros* "wheel" configuration technology, using the same combination of spin-stabilization and quarter-orbit magnetic torquing to maintain two-axis yaw and roll control.

Control of the third, or pitch, axis is effected by incorporation of a single, large, controllable spinning flywheel that transfers the spin momentum of the satellite to the wheel, thereby de-spinning the payload portion of the satellite.

This, in effect, creates a two-part satellite structure. One portion contains the spinning flywheel, and the other becomes a stabilized platform that can be controlled through control of the flywheel to rotate through precisely one revolution per orbit so that one portion of the payload structure—bearing cameras, directional antennas, or instrumentation—can be made to face the Earth at all times.

This capability greatly reduces the requirement for image motion compensation for satellite-based surveillance systems.

● **Nimbus use**—Within the weather satellite area, RCA now is working under a three-month NASA/Goddard contract to study the feasibiliy of using Stabilite with a *Nimbus* weather satellite. While *Nimbus* is now relegated to R&D status, it is expected that the development effort on particular subsystems will feed the eventual deployment of a second generation post-*Tiros* system. Viewed as particularly auspicious for future metsats is the *Nimbus* large-base-area sensor ring upon which many different types of sensors can be deployed.

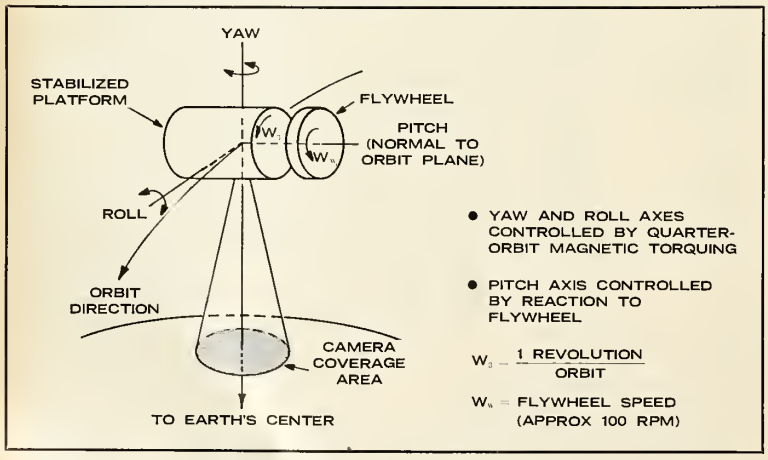
RCA officials here are hopeful that Stabilite will be test flown aboard a *Nimbus* R&D vehicle. The current *Nimbus* design also calls for a three-axis system, more complex than Stabilite, employing three smaller reaction wheels, eight gas jets, and a rate gyro.

The original *Nimbus* system, though less attractive in terms of complexity, does represent higher potential accuracies and faster time constants in response to perturbations, according to NASA officials.

Its possible use in the *Tiros* program, first aboard a wheel-type R&D vehicle to test feasibility and then perhaps as a means to stabilize special satellites of a *Tiros* operational system (now under development for the Weather Bureau) to provide IR scanning measurement, is also reportedly being looked at by the Weather Bureau. The IR limitations of the "rolling" *Tiros* wheel design were first pointed out in MISSILES AND ROCKETS (June 3, 1963, p. 17).

RCA has also advanced Stabilite for a biological satellite, again built around the *Tiros* structural design it has proposed to NASA. The proposal is being evaluated by NASA headquarters and the Ames Research Center.

RCA scientists feel the system, possibly in conjunction with on-board TV, would allow spaceborne testing of animals and plant life in a de-spun zero-g satellite environment for long periods, with the ability to increase the g-forces



SIMPLIFIED DRAWING illustrates basic three-axis attitude control used in "stabilite".

through positive control of the flywheel, and observe the effects.

The same basic concept they feel is applicable to space stations, and the firm is known to have already proposed to NASA the use of the *Tiros* magnetic torquing concept for two-axis control of space stations.

The firm also recently completed an Air Force study contract aimed at using the system to point a corner reflector mounted aboard a satellite as a means to calibrate missile/space range radars. The report is now in Air Force hands.

● **AF, Navy interest**—Use of the system as a means for surveillance and reconnaissance is known to have attracted Air Force and Navy interest for both ground and fleet reconnaissance, but RCA officials declined to comment on proposals in this area. In discussing Stabilite with respect to one unclassified use, however, the system was described as "space-qualified," which indicates that the complete system, or most major components, may have already been test-flown aboard a military satellite.

RCA will not propose use of Stabilite in connection with its joint efforts with American Telephone & Telegraph in the recent ComSat Corp. satellite design studies (M/R, June 15, p. 18). But scientists here feel that should a military comsat program get a go-ahead signal, the three-axis approach system would be advanced as a means to allow use of highly directional antennas.

Use of Stabilite is not included in RCA's recently proposed SONG (M/R, June 22, p. 17) navigation satellite system, though, again, military navsat proposals by the firm would likely include it in the design.

● **As applied to Tiros**—In discussing the Stabilite operation, RCA officials cite its use in a *Tiros* wheel design as an example. In this case, simple despin devices, or "yo-yo's," are first deployed to reduce the initial spin of the satellite from a nominal 175 rpm to about 12-15 rpm. By periodically switching the direction of current transmitted from the ground to the torquing coils aboard the satellite (which interact with the Earth's magnetic field), the satellite is then rotated 90 degrees until the spin axis is normal to the orbit.

In this so-called wheel position, the optical axes of the sensors lie in a plane that contains the spin axis of the satellite. Only infrequent (once a week or less) ground commands are required to maintain two-axis satellite position, according to RCA.

The sensing systems used for this roll/yaw control are two canted thermistor bolometers mounted on the Stabilite flywheel, and which respond to Earth-sky sky-Earth transitions. The time between these two transitions is measured at ground stations and corrective action is initiated as needed.

With the satellite in this position, an on-board standard d-c motor used for pitch control is actuated, causing the flywheel to begin to pick up speed to a nominal 100 rpm rate. This, through the laws of conservation of momentum, effectively reduces the satellite payload-carrying structure rotation rate to one revolution per orbit, which, in effect, continuously maintains the cameras in the proper Earth viewing position.

Where launch vehicles are used that do not impart a spin to the satellite, the pitch-control motor could be used to spin a portion of the satellite before separation and therefore still allow taking advantage of the inherent stability against perturbations provided by the spin stabilization principle, according to RCA.

A closed-loop feedback control system, independent of ground command, is used to maintain control about the pitch axis. There is, however, a manual override in this mode via ground command inputs to the pitch motor.

● **Pinpointing local vertical**—A third horizon sensor, whose function is to detect the local vertical, is also mounted on the radial axis of the flywheel between the two canted devices. The sensors used are standard *Tiros* types supplied by Barnes Engineering Co.

A magnetic "piper" device is also mounted on the camera shaft. The rotating flywheel senses the pulsed output of each of these position-marking devices 100 times a minute. The duration of the voltage setup between the two sensors is proportional to the angular error between the camera and the local vertical, and the sign of the voltage indicates the direction.

The on-board control networks use the error signal to adjust the reaction torque between the flywheel and the stabilized platform. The correction rate, which has an effect on camera "jitter," or undesirable movement about any axis (which is very important in terms of high-resolution camera work), would be adjusted for particular missions.

As an example of the time involved in making corrections, RCA notes that if the maximum allowable camera jitter rate is 0.01 deg/sec and the flywheel is rotating at 360 deg/sec, a position error of one degree would take 100 secs.

RCA scientists told M/R that Stabilite can be currently designed to maintain jitter rates at this 0.01 deg/sec level and that refinements are possible to allow rates on the order of 0.001 deg/sec. Overall camera pointing accuracy is reportedly on the order of 0.1-0.5 deg.

● **Weight and power**—According to RCA figures, Stabilite would consume 5-10% of the vehicle weight in which it was placed and require between 3-8 watts average power. About 60% of the system's weight is taken up by the flywheel structure. In all cases, flywheel size would be as large as the satellite structure permitted, and wheel weight would be arrived at as a trade-off against the type of dampers used and the angular momentum required to provide adequate spin stabilization.

Completely filled fluid nutation dampers are mounted on the payload portion to help eliminate roll/yaw jitter. Pitch rate error is essentially reduced through pitch servo design, involving use of high-resolution feedback components and flywheel rotation rates high enough for rapid error sampling.

RCA says a one-year lifetime is now practical and that five years is possible with refinements made either to the standard d-c motors or with new brushless motors being developed.

While virtually all the RCA proposals have been in the near-Earth bracket, scientists here speculate that use of the magnetic torquing might be feasible at intermediate (6,000-8,000 mi.) altitudes. One scientist reports that with power availabilities and allowable increases in magnetic coil size, operation at synchronous altitudes might even be feasible. Studies in both of these areas are going on in-house.

While the magnetic fields are weaker at these altitudes, scientists note that the disturbing forces should also be weaker. RCA also points out that high-altitude operation could also be achieved using gas jets instead of the magnetic torquing in combination with the pitch-control.

● **Advantages cited**—In promoting Stabilite, RCA officials cite reduced complexity over competitive three-axis systems, and proven componentry as major advantages.

While new gravity-gradient stabilization methods show promise for some satellite missions, such as a commercial communications satellite, officials here feel, for camera operations in particular, the system offers reduced jitter and system complexity, and increased position control advantages over gravity-gradient systems. They cite increased complexity of three-axis gravity gradient systems caused primarily by multiple-boom requirements and libration damper limitations.

Another factor that could swing stabilization decisions away from gravity gradient for some applications, as one NASA official points out, is the fact that they can't be fully demonstrated on the ground. "You've got to fly it, and this one-shot type of thing has gotten the *Transit* (navsat) boys in trouble a few times." ■

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The Industry Week

Mergers and Acquisitions

Dow Corning Corp., Midland, Mich., has purchased the Alpha-Molykote Corp., Stamford, Conn., manufacturer of lubricants and associated test equipment. A-M will be operated as a wholly owned subsidiary of Dow Corning. . . . *Fruehauf Corp., Detroit, Mich., has acquired Hanson Bros., Inc., Whittier, Calif., supplier of missile components ground handling and ground support equipment. Hanson will become part of Fruehauf's Military Products Div.-West, Fullerton, Calif.* . . . Warner & Swasey Co., Cleveland, Ohio, has purchased the business and assets of Wiedemann Machine Co., King of Prussia, Pa. Wiedemann produces testing machines and related equipment for testing materials and structures. . . . *Ling-Temco-Vought, Inc., is extending until July 2 its stock exchange offer to shareholders. The company is offering $15 cash and one share of a new series B preferred stock for each three shares of common stock (M/R, June 8, p. 43).*

Artificial Solar Source Invented

Engineers at Vitro Corp. of America's Laboratories Div., West Orange, N.J., have invented an intense light-energy source for application in solar simulation. The source is an electric arc configuration consisting of a center cathode and annular anode pointed in the same direction. An inert gas is passed through holes in the anode resulting in a plasma jet adjacent to the cathode. The jet can be shaped into a plasma ball by application of a magnetic field. Vitro says the arc has the ability to generate a peak brightness of 5,000 candles/sq. mm.

Lockheed Bibliography

A bibliography covering available information in all languages for hundreds of areas of missile/space technology has been published by Lockheed Missiles & Space Co., Sunnyvale, Calif. The "Bibliography of LMSC Bibliographies" provides a collection of references on specific areas being researched, thus helping to avoid unnecessary investigation. The company has five literature researchers who review reports from 150 U.S. information centers.

New Activities

Material Measurements, Inc., has been formed in North Hollywood, Calif., to develop advanced ultrasonic test equipment. Kermit Skeie is president of the new firm. . . . *Dynatech Corp., Cambridge, Mass., and Johns-Manville Corp., New York City, have signed an agreement giving Dynatech exclusive license to manufacture and market the J-M Rapid Heat Flow Meter Thermal Conductivity Instrument in this country.* . . . Reeves Industries, Inc.'s Soundcraft Div., Danbury, Conn., and Ex-Cell-O Corp. have signed an agreement licensing Ex-Cello-O's Bryant Computer Products Div., Walled Lake, Mich., to use Reeve's Magna-Plate process for production of magnetically plated drums and discs. . . . *Milan G. Weber Associates has been organized in Deerfield, Ill., as an aerospace management consulting firm.* . . . The Mitre Corp., Bedford, Mass., has reorganized its Technical Staff into six divisions in order to better match those of the firm's principal sponsor, Air Force Systems Command's Electronics Systems Div. The new divisions are: Systems Planning, Systems Engineering, Information Systems Laboratories, Communications and Sensor Systems Laboratories, Defense Communications Agency and Air Traffic Systems.

Company Facilities

Air Reduction Sales Co., New York City, is constructing a multi-million-dollar liquid oxygen-nitrogen plant at Cape Kennedy. The facility will have a production capacity of 1,000 tons per day in support of space programs, particularly Project *Apollo.* . . . *Space Ordnance Systems, Inc., El Segundo, Calif., has leased a 6,000-sq.-ft. factory and office building adjacent to its present facilities. The firm develops and manufactures explosive ordnance for the missile/space industry.* . . . Dana Laboratories, Inc., will move into a $300,000 facility in the Irvine Industrial Park, Irvine, Calif. Dana produces digital voltmeters and dc amplifiers. . . . *Thiokol Chemical Corp.'s Panelyte Industrial Div., Trenton, N.J., is beginning a 2-year development program designed to modernize production facilities and increase efficiencies. The program is estimated at $2,000,000.* . . . Intellux, Inc., is constructing a 34,000-sq.-ft. building in Santa Barbara Research Park, Goleta, Calif. The firm produces microcircuit logic modules. . . . *Emtec, Inc.'s Components Div. is moving into a new plant in Canoga Park, Calif. The division manufactures precision fasteners for the missile/space and military markets.*

International

Hughes Aircraft Co., Culver City, Calif., and Eltro GmbH & Co., Heidelberg, Germany, have formed a new firm to develop and produce advanced laser and infrared equipments. The company is Eltrughes Strahlungstechnik GmbH & Co. and will be located in Heidelberg. Hughes and Eltro each hold 50% of the ownership. . . . *National Aeornautical Corp., Fort Washington, Pa., has purchased MEDCO Instruments, Inc., Montreal, Canada, manufacturer of electronic instruments. It will be operated as a subsidiary of Air-Shields, Inc., Hatboro, Pa., a subsidiary of NAC.* . . . Simpson Electric Co., Chicago, and Ruttonsha, Ltd., have formed a new firm in Bombay, India, to be known as Ruttonsha-Simpson Private, Ltd. Ruttonsha produces electronics meter and test equipment. . . . *The Cameca Co., Courbevoie, France, has appointed Acton Laboratories, Inc., Acton, Mass., as sole sales representative and distributor for its Electron Probe X-Ray Micro-analyzer in North America.*

contracts

AWARDS

AIR FORCE

$3,310,969—**General Dynamics Corp.,** San Diego, Calif., to produce *Atlas* missiles and related materials.

$2,866,586—**RCA Service Co.,** Camden, N.J., for technical service on BMEWS.

$2,200,000—**Sperry Rand Corp.,** Phoenix, Ariz., for components for gyroscopic compasses.

$1,250,000—**North American Aviation, Inc.,** Anaheim, Calif., for further work on GSE for *Minuteman* guidance and control system.

$1,200,000—**Radio Service Co.,** Melbourne, Fla., for a data processing system related to ballistic missile re-entry.

$1,200,000—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for a research evaluation of the *Pershing* missile system.

$1,060,000—**Hughes Aircraft Co.,** Fullerton, Calif., for modifications to the air defense operation systems.

$900,000—**North American Aviation, Columbus Div.,** Columbus, Ohio, to design, develop and demonstrate an advanced air-to-surface missile to destroy tanks and other vehicular targets.

$500,000—**Weinschel Engineering,** Gaithersburg, Md., for the manufacture of precsion microwave attenuation and power measuring equipment.

$333,203—**General Electric Co., Missile and Space Div.,** Philadelphia, for orbital space station studies.

$330,000—**Martin Marietta Corp., Baltimore Div.,** Baltimore, for orbital space station studies.

$325,000—**Douglas Aircraft Co., Missile and Space Systems Div.,** Santa Monica, Calif., for orbital space station studies.

$252,850—**United Aircraft Corp., United Technology Center,** Sunnyvale, Calif., for reimbursable items for maintenance operation, repair and calibration of facilities on solid motor development complex 1-36.

$205,533—**Ladish Co.,** Cudahy, Wisc., for development of manufacturing processes for forging engine parts made from high strength beryllium.

$183,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., for the development of advanced solid-state telemetry transmitter techniques.

$100,000—**Boeing Co., Aerospace Div.,** Seattle, Wash., for X-20 guidance and control dynamic model.

$100,000—**Inca Engineering Corp.,** Pasadena, Calif., for two programs to complete designs of two high performance rocket sleds.

$84,245—**Aerojet-General Corp.,** Sacramento, Calif., for packageable high expansion ratio solid rocket motor nozzles.

$72,000—**Itek Corp.,** Lexington, Mass., for the study of lasers as an optical measuring technique.

$50,000—**National Research Corp.,** Cambridge, Mass., to study the "cold welding" of various metals in the extreme high vacuum environment of outer space.

$43,525—**General Motors Corp., AC Spark Plug Div.,** Milwaukee, Wisc., for replacement parts required to support the CGM-13B missile weapons system.

ARMY

$12,500,000—**Sylvania Electric Products, Inc.,** New York City, to develop and produce classified electronic equipment.

$5,500,000—**Bendix Corp.,** Baltimore, for classified electronic equipment.

$2,873,885—**Martin Marietta Corp.,** Orlando, Fla., for industrial engineering for *Pershing* weapons system.

$1,300,000—**Melpar, Inc.,** Falls Church, Va., for work on a classified electronics R&D program.

$1,282,660—**Western Electric Co.,** New York, for *Nike-Hercules* GS-65250 guidance section.

$1,192,580—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for *Pershing* missile study.

$1,100,000—**General Dynamics Corp.,** Rochester, N.Y., for two design models related to electronic countermeasures.

$1,069,179—**Kaminer Construction Corp.,** Huntsville, Ala., for acoustic model test facility at Marshall Space Flight Center.

$500,000—**Allen Electric & Equipment Co.,** Kalamazoo, Mich., to produce testing equipment for the U.S. Army Weapons Command.

$308,000—**Honeywell, Inc.,** Minneapolis, Minn., for an on-board digital computer.

$174,434—**North American Aviation, Inc.,** Columbus, Ohio, for continuation of flight service program utilizing the *Roadrunner* target missile system.

$141,702—**Western Electric Co.,** New York, for procurement of *Nike* replenishment repair parts.

$102,650—**Martin Marietta Corp.,** Orlando, Fla., for R&D engineering services for *Pershing* weapons system.

$100,000—**Douglas Aircraft Co., Inc., Charlotte Div.,** Charlotte, N.C., for replenishment spare parts for *Nike* missile systems.

$60,507—**Stanford Research Institute,** Menlo Park, Calif., for conducting presentation methods of topside electronic density profiles.

$44,115—**Vitro Corp. of America, Vitro Electronics Div.,** Silver Spring, Md., for a telemetry receiver in various quantities.

$43,411—**Martin Marietta Corp.,** Orlando, Fla., for modification kits for the *Pershing* missile system.

$41,748—**Consolidated Systems Corp.,** Monrovia, Calif., for a micrometeoroid sensor laboratory model and electronics breadboard.

$34,400—**Micro Gee Products, Inc.,** Burbank, Calif., for a two-axis oscillating rate table with amplifier and servo analyzer.

$32,275—**Genisco Technology Corp., Data Div.,** Compton, Calif., for a magnetic tape recorder/reproducer system.

$28,918—**Raytheon Co., Industrial Products Div.,** Newton, Mass., for engineering design and fabrication of a multiple filter spectrum analyzer.

NAVY

$8,500,000—**Raytheon Co.,** Lexington, Mass., for several contracts to develop search-surface radar and to produce electronic assemblies for *Polaris* missile guidance systems.

$7,749,252—**General Electric Co.,** Schenectady, N.Y., to manufacture guidance system components for the *Polaris* missile.

$5,900,000—**Hughes Aircraft Co.,** Culver City, Calif., for further production of *Polaris* guidance assemblies.

$5,368,706—**Atlantic Research Corp.,** Alexandria, Va., for production of rocket motors for *Terrier* missiles.

$4,225,000—**Lockheed Aircraft Corp.,** Redlands, Calif., to produce a gas-generator blowing system for Dolphin and Thresher class submarines.

$1,000,000—**Northrop Corp., Nortronic Div.,** Anaheim, Calif, for automatic test equipment for missile checkout aboard *Polaris* submarines.

$492,932—**Loral Electronics Corp., Military Electronics Div.,** Bronx, N.Y., for development and systems integration of the A NEW Mod. 11 airborne ASW system.

$74,741—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for a R&D program directed at optimization of structural components for hypersonic guided missiles.

$48,484—**Collins Radio Co.,** Dallas, for digital data communications equipment.

$45,330—**Astrodata, Inc.,** Anaheim, Calif, for a missile lift-off indication system.

$35,000—**Northwestern University,** Evanston, Ill., for analytical systems support for various weapons systems.

$27,956—**Precision Instrument Co.,** Pasadena, Calif., for digital magnetic tape recorder-reproducers.

USMC

$6,300,000—**Radio Corp. of America, Surface Communications Div.,** Camden, N.J., for a lightweight, highly reliable microwave radio relay set capable of over-the-horizon communications.

NASA

$20,000,000—**Collins Radio Co.,** Dallas, to provide a world-wide spacecraft ground tracking network in support of the *Apollo* program.

$1,500,000—**General Electric Co., Radio Guidance Operation, Defense Electronics Div.,** Syracuse, N.Y., to provide a real-time impact prediction and data processing system for Wallops Station, Wallops, Va.

$840,000—**Purdue University,** Lafayette, Ind., to finance construction of additional laboratory and rocket-firing facilities.

$556,158—**Lockheed Aircraft Corp.,** Burbank, Calif., for purchase of the XH-51N hingeless rotor helicopter for use in flight research at Langley Research Center, Hampton, Va.

$544,299—**Hayes International Corp.,** Birmingham, Ala., to increase the existing contract for R&D fabrication services for George C. Marshall Space Flight Center, Huntsville, Ala.

$479,000—**Interstate Engineering Corp., Interstate Electronics,** Anaheim, Calif, for development of a generalized tracking receiver and demodulator system.

$400,000—**Bissett Berman Corp.,** Santa Monica, Calif., for studies pertaining to *Apollo* mission planning and guidance, and navigation system analysis and related tanks.

$145,303—**Monsanto Research Corp., Boston Labs Div.,** Everett, Mass., for a study of dual cells using storable rocket propellants.

$122,253—**Astrodata, Inc.,** Anaheim, Calif, for a high speed data acquisition system.

$80,938—**Systron-Donner Corp.,** Concord, Calif., for instrumented acceleration measuring system for *Apollo* flight test program.

$69,059—**Bendix Corp.,** Hollywood, Calif., for PCM ground documentation system.

$60,000—**Honeywell Inc., Aeronautical Div.,** Minneapolis, Minn., for *Apollo* command module autopilot components.

Planning Research Corp. of Westwood, Los Angeles, follow-on contract to continue reliability reviews of NASA's *Orbiting Geophysical Observatory* program (amount undisclosed).

AC Spark Plug, Milwaukee, Wisc., prime contractor for furnishing complete *Apollo* guidance and navigation systems (amount undisclosed).

Bower Associates, Inc., Minneapolis, Minn., to evaluate and report on the quality control and reliability of the *Echo II* program (amount undisclosed).

INDUSTRY

$2,700,000—**Collins Radio Co.,** Dallas, from **Radio Corp. of America,** New York City, to provide certain equipment in the communication system of the Project *Apollo* LEM.

$1,000,000—**Northrop Corp., Nortronics Div.,** Anaheim, Calif., from **Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for a supplemental contract to provide automatic test equipment for missile checkout equipment (DATICO) for *Polaris* submarines.

$150,000—**Computer Sciences Corp.,** El Segundo, Calif., from the **Calif. Institute of Technology's Jet Propulsion Lab.,** Pasadena, Calif., for computer programming service.

$100,000—**National Research Corp.,** Newton, Mass., from **F. J. Stokes Co., Space Systems Div.,** Philadelphia, for 26 diffusion pumps to be used on *Apollo* space simulation facilities.

$100,000—**Chem-Electro Research, Inc.,** Sun Valley, Calif., from **North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for high reliability ceramic capacitors for the *Apollo* space program.

Walter Kidde & Company, Inc., Belleville, N.J., from **General Dynamics/Convair,** San Diego, for nine reaction control systems for the *Little Joe II* (amount undisclosed).

ARMS CONTROL & DISARMAMENT AGENCY

$164,186—**Stanford University,** Stanford, Calif., for a study respecting problems bearing on possible regional arms control and disarmament arrangements for the Far East.

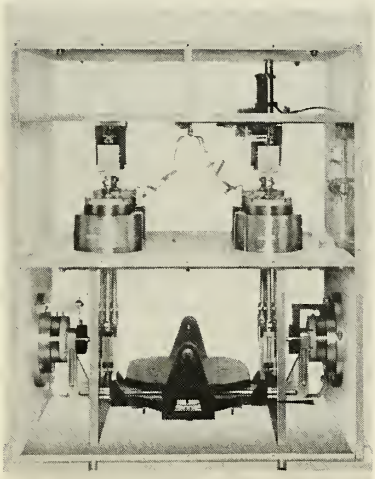
New Product of the Week:

2-Axis Simulator

A 2-axis simulator, ± 10 degrees both axes, and designed to test gyros and accelerometers in a radiation environment, has been announced by Micro Gee Products, Inc.

Each axis is driven by a closed-loop dc servo system with a maximum frequency of 50 cps, maximum acceleration of 5,000 degrees/sec.^{2} and maximum rate of 200 degrees/sec.

The system utilizes linear electromagnets and driven pendulums to drive a platform on two pendulous axes and was fabricated without use of lubricants, rubber or other materials subject to radiation damage. The device is similar to other 1-, 2- and 3-axis models produced by the firm except the radiation model has the platform on the bottom instead of the top.



Circle No. 151 on Subscriber Service Card

Ionization Gauge Control

The Model VMV-400 ionization gauge control, featuring both vacuum measurement and automatic control, is available from Nuclear Corp. of America.

The unit provides vacuum measurements down to $2x10^{-12}$ torr, read on seven linear meter scales. One logarithmic scale covers the range from $1x10^{-3}$ to $1x10^{-10}$ torr. Drift characteristic is 1% over an ambient temperature range of zero to 50° C. The ionization gauge tube may be operated at distances up to 100 ft. from the gauge control without sacrificing accuracy.

Circle No. 152 on Subscriber Service Card

Variable Attenuator

E & M Laboratories has available two models of its line of ferrite variable attenuators.

Model XL102VA provides continuously variable attenuation from 1.0 to 30 db over a frequency range of 7.05 to 10 gc. Model XL101VA has an attenuation range of 0.7 to 35 db and a frequency band of 8.0 to 9.0 gc.

Both units have a VSWR of 1.25 maximum, driving current of less than 200 ma and average power rating of 1 watt.

Circle No. 153 on Subscriber Service Card

Laser System

Maser Optics, Inc., is marketing the Model 6400 oscillator-amplifier laser system, capable of generating peak power outputs in excess of one billion watts.

The system utilizes two Model 3200 ruby lasers connected in an oscillator-amplifier realtionship. Gain is from 2 to 10, depending on the mode of operation. Identical crystal temperatures are maintained in the two components. The oscillator section utilizes 90,000-rpm rotating prism-type Q-switching. Output energy levels are from 5 to 10 joules.

Circle No. 154 on Subscriber Service Card

Laminating Resin

Monsanto Co.'s Plastics Div. has developed Skygard 700, a laminating resin designed for use in production of missiles, aircraft and reinforcement parts.

Described as a heat reactive aromatic polymer system containing active amino and carboxyl groups, the material can withstand temperatures up to 700°. Storage life is one month at 70°F or six months at 40°F.

Circle No. 155 on Subscriber Service Card

Circuit Analyzer

Military Electronics Div. of Ling-Temco-Vought, Inc., is marketing a solid-state circuit analyzer that utilizes perforated control tape employing direct launchage and the standard EIA code.

The unit has a capacity of 400 measurement test points and 16 command outputs. Capability of 2,000 test points and 400 commands may be obtained by the addition of switch and command units. The device meets MIL-T-21200 specifications.

Circle No. 156 on Subscriber Service Card

High-Intensity Mike

Gulton Industries, Inc., has introduced a high-intensity microphone for measurement of acoustic sound levels in severe vibration and high-temperature environments.

The Model MD299503 achieves vibration compensation by use of two identical seismic elements, oppositely connected. Output due to 1-g RMS will not exceed that obtained at 90-db sound pressure level. SPL sensitivity is 0.5 mv minimum at 120 db. The device is hermetically sealed and operates in the temperature range of — 65° to 400° F. Dynamic range is 190 db; non-linearity is less than 0.5 db.

Circle No. 157 on Subscriber Service Card

Cavitating Venturis

Fox Valve Development Co. has available a kit of cavitating venturis in incremental sizes suitable for basic research on propellant performance and combustion phenomena.

The devices can be used to maintain constant flow of cryogenics, slurries, liquid metals and exotic fluids



despite wide variations in downstream pressures. Each stainless steel unit is water-flow calibrated and subjected to recovery determination tests.

Circle No. 158 on Subscriber Service Card

Power Supply

A multi-level power conditioning supply for digital computers using micro modules has been developed by Data & Controls Div. of Lear Siegler, Inc.

The Model VR-413072-9A maintains 2% regulation within input transients of 54 to 180v ac. At frequencies from 380 to 420 cps, outputs are: 3.65v at 15 amps; — 3v at 1 amp; 30v at 0.5 amps, — 25v at 0.2 amp; 10.5v at 1 amp, — 10v at 0.4 amp and 300v at 25 ma.

Circle No. 159 on Subscriber Service Card

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40 Circle No. 10 on Subscriber Service Card

Synchronization System

A drum synchronization system designed to increase digital computer storage capability and provide faster access to stored information is available from Sequential Electronic Systems, Inc.

The Model DS11 has a time displacement error of less than 0.2 μsec. and is adaptable to multiple drum synchronization allowing transfer of information from one drum to another without information loss. The unit meets all applicable military specifications.

Circle No. 160 on Subscriber Service Card

Communications Antenna

An 8-ft. communications antenna for operation in the frequency band of 1,700 to 2,400 mc is available from Technical Appliance Corp.

The Model AS-554/U is of four-section construction and can be rotated 360 degrees in azimuth and ±10 degrees in elevation. Power handling capability is 190 watts; HPWB is 4.0 degrees; gain is approximately 34 db and impedance is 50 ohms.

Circle No. 161 on Subscriber Service Card

Line Restorer

Digital Products Div. of Hyperion Industries, Inc., is marketing the Model HI-327 line restorer.

The device can accept any of the standard 1-kc amplitude modulated codes, such as IRIG-B, AMR-D5 and NASA-36 and others with input voltage levels from 0.5 to 5v peak-to-peak at modulation ratios of 2:1 to 5:1. Input impedance is balanced at 600 ohms. Power input is 105 to 125v, 50 to 440 cps. Operating temperature is −25° to 55°C.

Circle No. 162 on Subscriber Service Card

Power Divider

Radar Design Corp. is marketing the Model D-2446 power divider, offering isolation between outputs greater than 40 db.

The unit measures 3½ in. across and has three mounting holes, 8-32 tap, equally spaced. Specifications include: frequency, 470 to 890 mc; connectors, type N; outputs, 12; VSWR, 1.30 maximum; input-output attenuator, 22 db; power handling, 10 watts average.

Circle No. 163 on Subscriber Service Card

Delay Lines

A series of high-frequency magnetostrictive delay lines, capable of storing up to 6,000 bits as compared with 3,000 bits for previous comparable devices, has been developed by General Instrument Corp.

The HTDL series torsional delay lines can operate in shocks up to 80 g's. Operating frequency is up to 4 mc in the NRZ mode, with delays of from 60 to 1,500 ms. Frequencies up to 5 mc can be attained in lines of 10 to 60 ms. All lines are adjustable to ± 2 ms. Input is 30 ma with a pulse width of 180 nanosecs. Input impedance is approximately 750 ohms.

Circle No. 164 on Subscriber Service Card

Function Generator

A function generator that provides simultaneous sine and square wave functions from 0.005 cycle to 60 kilocycles is available from Hewlett-Packard Co.

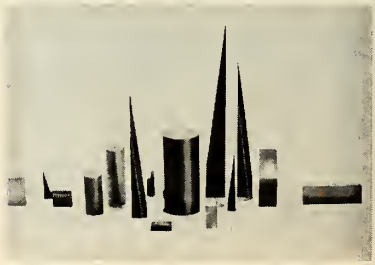
The Model 203A has separated outputs continuously phase-variable through a 360-degree range. Sine wave distortion is less than 0.06%. Square waves have a rise and fall time of less than 200 nanosecs. Frequency calibration exceeds ±1% accuracy.

Circle No. 165 on Subscriber Service Card

Microwave Absorbent

Adtek, Inc., is marketing a high-power silicone base microwave absorbing material available in a range of attenuations from 20 to 200 db/in. at 10 kmc.

Designated Custom Load 4201, the material has a service temperature of



−56° to 510°F. Water absorption is less than 0.1% and power capability is said to be 50% greater than that of epoxy type load materials. Custom Load is available in rod and sheet form and is machinable into unusual configurations.

Circle No. 166 on Subscriber Service Card

Bidirectional Counter

A portable bidirectional counter designed primarily to accept inputs from optical incremental encoders is available from Wang Laboratories, Inc.

The device has four decades plus sign of nixie tube in-line indication. Inputs are generally 2-phase. A dial indicator can be modified to provide digital readout in 0.0001-in. increments. Operating power is 115v ac, 60 cps.

Circle No. 167 on Subscriber Service Card

Rejection Crystal Filter

A 60-kc pilot rejection crystal filter, designed for use in carrier communication systems. has been introduced by Systems, Inc.

The Model A-24 has a 60-cps maximum bandwidth at 3-db rejection, 16 cps minimum at 80 db and 6 cps minimum at 100 db. Passband is 12 to 59.970 kc and 60.030 to 1,010 kc. Peak-to-peak ripple is 3 db maximum. Operating temperature range is 40° to 100°F.

Circle No. 168 on Subscriber Service Card

Flatness Interferometer

Engis Equipment Co. is marketing an interferometer that can measure scraped, ground, planed, lapped or optically worked surfaces with an accuracy greater than 0.002 in.

Surfaces measuring up to 48 in. long and 3 in. wide may be examined at a single viewing. Each fringe may be set to a grazing value of 0.00005, 0.00010 or 0.00015 in. and subdivided by a micrometer to provide readings to 0.1 of a fringe. The instrument can examine both horizontal and vertical surfaces.

Circle No. 169 on Subscriber Service Card

Sweeping Current Supply

A sweeping current supply for driving YIG microwave filters is available from Physical Electronics Laboratories.

The unit provides continuously adjustable output current from 0.4 to 1.3 amps at a voltage of 0.4 to 13v. Optimum load is 1 to 10 ohms and 80 millihenries inductance. The supply provides a current sweep over the full range of from 100 to 1/100 seconds. Sweep time is adjustable with a 10:1 vernier and a decade switch.

Circle No. 170 on Subscriber Service Card

Linear Video Voltmeter

Ballantine Laboratories is marketing the Model 311 G linear video voltmeter for use over wide voltage and frequency ranges.

The instrument has a frequency range of 10 cps to 6 mc and features a 1% accuracy f.s.d. from 40 cps to 1 mc. Bandwidth is 3 db from 2 cps to 10 mc. Voltage range is 1 mv to 300v full scale in 12 ranges. The device can be used up to 1,000 or 10,000v with optional accessories.

Circle No. 171 on Subscriber Service Card

Ceramic Capacitor

A subminiature solid-state ceramic capacitor, rated at 10,000 pf, is being marketed by U.S. Capacitor Corp.

The unit measures 0.185 in. long and 0.095 in. in diameter and is available in 100 and 200v dc with no derating over a temperature range of — 55° to 125 ° C. Capacitance values range from 1 to 120,000 pf with a total capacitance change of less than ± 15%. The device meets MIL-C-11015 specifications.

Circle No. 172 on Subscriber Service Card

Optical Pyrometer

A direct-reading optical pyrometer designed for measurement of temperatures above 760° C is being marketed by the Pyrometer Instrument Co., Inc.

The self-contained unit is calibrated against NBS certified standards and has an accuracy of 0.5% of the temperature being observed. It is available in seven temperature ranges.

Circle No. 173 on Subscriber Service Card

Dispersive Delay Line

Andersen Laboratories, Inc., is marketing the Model II dispersive delay line. Center frequency is 30 mc and variation in delay is 33.3 μsec. Other specifications include 83.5-μsec. delay at 30 mc; insertion loss, 45 db; input impedance of 17 ohms ± 5 ohms in parallel with 100 pf ± 20 pf.

Circle No. 174 on Subscriber Service Card

Electronic Micrometer

Wayne Kerr Corp. is marketing the Model B-721 electronic micrometer for



measurements in the 50 to 45,000-micro-inch range.

The device employs a non-contacting guarded-capacitance probe and utilizes the principle of the transformer-ratio-arm bridge. Measurement accuracy is 1% of the entire range. Remote measurements, up to 75 ft. from probe to meter, are possible without loss of accuracy. Operating power is 105 to 125v or 210 to 250v, 40 to 50 cps.

Circle No. 175 on Subscriber Service Card

Adhesive/Sealant

A silicone rubber adhesive/sealant, designed to withstand temperatures up to 40% higher than conventional silicone sealants, has been developed by General Electric Co.

The RTV-106 is a one-part material formulated to withstand long-term use at temperatures up to 600° F. The material cures overnight and is available in 3-oz. tubes, 6-oz. cartridges and 12-oz. tubes.

Circle No. 176 on Subscriber Service Card

Backward-Wave Oscillator

Stewart Engineering Co. is marketing a full K_u-band backward wave oscillator measuring 1½-in. square by 6 in. long and weighing less than 1½ lbs.

The Type SE-307 has a required maximum helix voltage of 2,000v and a cathode current not exceeding 10 ma. Focusing is accomplised by integral permanent magnet.

Circle No. 177 on Subscriber Service Card

Decade Resistance Standard

A decade resistance standard featuring accuracy of ±0.0025% and reactance of less than 0.1-degree phase angle at 10 kc is being marketed by General Resistance, Inc.

The Model RDS-615 contains six decades with individual controls and numeric displays. Range is 1 to 1,111,110 ohms. A calibration chart, traceable to the National Bureau of Standards, assures calibrated accuracy of ±5 parts per million.

Circle No. 178 on Subscriber Service Card

Waveguide Switch

A line of manually operated waveguide switches for the 2.6 to 18.0-gc range is available from DeMornay-Bonardi.

The units have a typical VSWR of 1.05; typical insertion loss of 0.05 db and typical isolation of 55 to 60 db. They meet MIL-T-21200 specifications.

Circle No. 179 on Subscriber Service Card

Tunable Filters

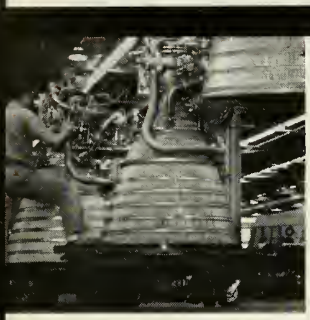
A series of tunable RF filters, developed specifically for the telemetering bands, is being marketed by Telonic Engineering Co.

The Model TTF may be specified in 3- or 5-section configurations according to frequency selectivity characteristics desired. Typical insertion loss of a three-section unit with a 0.5% bandwidth is 1.5 db, and a five-section 3.0-db VSWR in the passband is kept to 1:5/1 maximum.

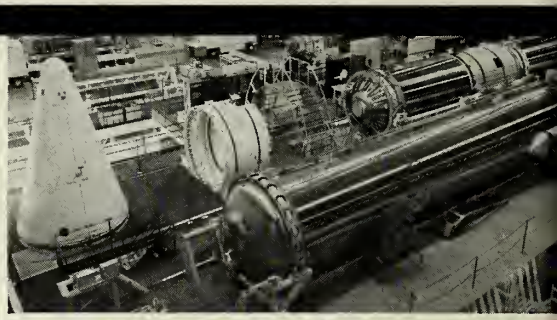
Tuning ranges available are 210 to 265 mc, 1,425 to 1,545 mc, 1,700 to 1,860 mc and 2,190 to 2,310 mc.

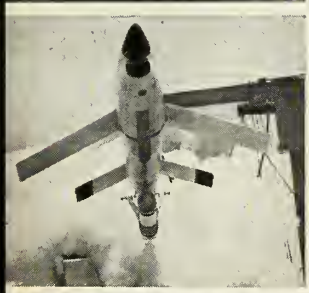
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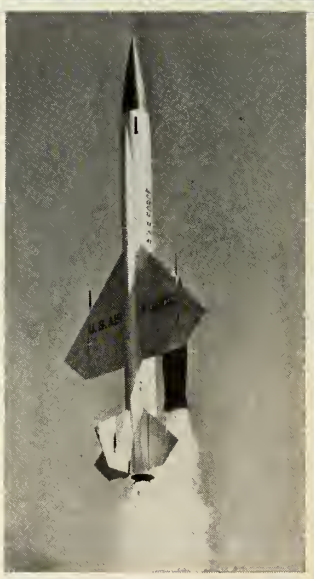
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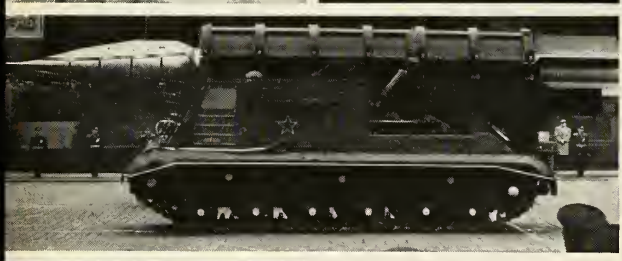






















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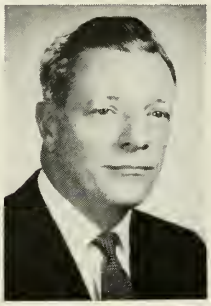
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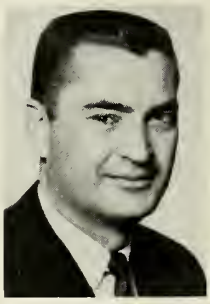
**45,000 paid subscribers plus 8,000 bonus circulation requested by NASA and military agencies.*

published: july 27, 1964
advertising closes: july 13, 1964

names in the news


BERTEA


HAYDEN


KELLER


FRASSETTO


HARRIS

Richard Bertea: To assume presidency of newly combined Bertea Design and Bertea Products, Pasadena, Calif.

M. A. Hayden: Named president of Vickers Inc., division of Sperry Rand Corp., Detroit. **William F. Driver** named vice president-general manager of the Machinery Hydraulics div.

Joseph F. Degen: Named president of Price Electric Co., a division of Consolidated Electronics, New York City.

Walter L. Deemer: Newly-appointed Deputy Chief of Operations Analysis, Office of the Vice Chief of Staff, Headquarters, U.S. Air Force.

Joseph M. Turner: Appointed assistant to the president, Aero Geo Astro Corp., Alexandria, Va.

Robert E. Gradle: Named vice president and general manager of Bellcomm, Inc., Washington, D.C.

Stanley S. Keller: Elected financial vice president of Datapulse Inc., Inglewood, Calif.

F. William Monge: Promoted to vice president and manager of the Virginia div. of Electro-Tec Corp., Ormond Beach, Fla.

Charles H. Bell: Elected vice president for marketing at Dortech Inc., Stamford, Conn., a subsidiary of Dorr-Oliver Inc. **Bruno S. Frassetto:** Elected vice president for engineering at Dortech.

George Gerard: Elected corporate vice president of Allied Research Associates, Concord, Mass. He will be responsible for the applied and theoretical research activities in the engineering sciences in the ARA div.

Sigmund P. Harris: Recently joined Maremont Corp., Pasadena, Calif., as senior physicist. He will be working on the development of a new ion engine for interplanetary spacecraft.

Raymond M. Warner: Promoted to director of engineering at Motorola's Semiconductor Products div., Phoenix, Ariz.

James B. Edson: Appointed director of engineering for Aerospace Research, Inc., Boston.

Grace Murray Hopper: Manager of Programming Research for UNIVAC div. of Sperry Rand, awarded the 1964 Achievement Award of the Society of Women Engineers in New York City.

Dr. Hugh L. Dryden: Deputy Administrator of NASA, received the 1964 Louis W. Hill Award of the American Institute of Aeronautics and Astronautics for "his personal contribution in fluid mechanics research leading to the space era, for technical leadership of the NACA and NASA teams bringing to fruition U.S. civilian space ventures, and for his personal contribution to the *X-15* research airplane program."

Leslie F. Muter: Board chairman of the Muter Co., Chicago, retired as treasurer of the Electronics Industries Assn., a post he has held since 1938.

William E. Shoupp: Elected president of the American Nuclear Society at the 1964 annual meeting. He is vice president of research for Westinghouse Electric Corp., Pittsburgh.

E. O. Hartig: Manager of the electronic engineering div. of Goodyear Aerospace Corp., Akron, Ohio, named to the U.S. Air Force Scientific Advisory Board.

Harper Q. North: Vice president of R&D for Thompson Ramo Woolridge Inc., Redondo Beach, Calif., elected president of the Electronic Industries Assn.

J. A. Milling: President of the Sams Div. of Howard W. Sams & Co., Inc., Indianapolis, Ind., elected treasurer of the Electronic Industries Assn.

W. Deming Lewis: To become next president of Lehigh University, Bethlehem, Pa., Oct. 11. He was formerly research director of the Bell Systems.

Hart Perry: Elected to board of directors of ITT Corp., New York.

Bethuel M. Webster: Elected to board of trustees of Systems Development Corp., Santa Monica, Calif.

Marvin P. Eisen: Appointed vice president, marketing, for Marshall Laboratories, Torrance, Calif.

Theophile J. Meek, Jr.: Elected vice president of Page Communications Engineers, Inc., Washington, D. C. He will be deputy general manager & technical director of Edison-Page, Rome, Italy.

Ralph L. Parr: Recently elected vice president of marketing and member of the Board of Directors at Aerospace Electronics, Inc., Atlanta, will direct newly opened offices in Florida.

Alan J. Grant: Appointed executive vice president of Guidance and Control Systems div. of Litton Industries, Beverly Hills, Calif. He was formerly with North American Aviation, Inc.

Rowland C. W. Brown: Elected vice president of Dorr-Oliver, Inc., Stamford, Conn. He is also secretary and treasurer of the corporation.

John W. Guilfoyle: Elected vice president of ITT Corp., New York City, and appointed ITT group executive-U.S. Defense/Space Group.

W. A. Schneider: Elected to newly created position of vice president-marketing of Lockheed Electronics Co., a division of Lockheed Aircraft Corp., Plainfield, N.J. **R. D. Chandler:** Assumed Schneider's former position as general manager of the Engineering Services Div.

Alfred Corbin: To assume newly created position of vice president of engineering for Metric Systems Corp., Fort Walton Beach, Fla.

Franc M. Ricciardi: Elected vice president of Walter Kidde & Co., Inc., Belleville, N.J. He was formerly with Litton Industries.

L. Edwin Smart, Jr.: Elected vice president of International Operations of The Bendix Corp., New York City. He was also elected to the corporation's administration committee.



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—when and where—

JUNE

First Annual Meeting and Technical Display of the AIAA, Sheraton-Park Hotel, Washington, D.C., June 28-July 2.

Aerospace Reliability and Maintainability Conference, sponsored by the SAE, ASME and AIAA, Statler-Hilton Hotel, Washington, D.C., June 29-July 1.

First International Congress on Vacuum in Space Research, French Society of Vacuum Engineers and Technicians, Paris, June 29-July 13.

JULY

Annual Meeting of the National Society of Professional Engineers, Grove Park Inn, Asheville, N.C., July 1-4.

Seminar in Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries, sponsored by the Contract Measurement Institute, Savoy-Hilton Hotel, New York City, July 6-10.

International Symposium on Magnetohydrodynamic Electrical Power Generation, European Nuclear Energy Agency and the Institut National des Sciences et Techniques Nucleaires, Paris, July 6-10.

Concentrated Vortex Motions in Fluids, AF Office of Scientific Research, ONR, NSF, NASA and the International Union of Theoretical and Applied Mechanics, University of Michigan, Ann Arbor, July 6-11.

20th Interagency Solid Propulsion Meeting, Sheraton Hotel, Philadelphia, July 12-15.

Aerospace Electrical/Electronic Supersonic Symposium, "Supersonic Aircraft—Avionics at Mach 3 and Beyond," Aerospace Electrical Society, International Hotel, Los Angeles, July 14-15.

Fourth International Symposium on Rarefied Gas Dynamics, sponsored by the AF Office of Scientific Research, ONR, NASA and the University of Toronto, Toronto, Canada, July 14-17.

Briefing Conference on Government Contracting for Research and Development, Federal Bar Assoc. and the Bureau of National Affairs, Statler Hilton Hotel, Boston, July 15-16.

Gordon Research Conference on Critical Tables and Progress in Science, Air Force Office of Scientific Research, New Hampton, N.H., July 20-24.

International Congress on Semiconductor Physics, sponsored by the AF Office of Scientific Research, NSF, ONR and the International Union of Pure and Applied Physics, Paris, July 20-24.

Meeting of the American Crystallographic Assoc., Montana State College, Bozeman, July 26-31.

Sixth International Symposium on the Reactivity of Solids, International Union of Biochemistry, New York Hilton and Americana Hotels, New York City, July 26-Aug. 1.

"Random Processes in Communication Systems," Polytechnic Institute of Brooklyn's Farmingdale Graduate Center, Farmingdale, N.Y., July 27-31.

AUGUST

First Research Conference on Instrumentation Science, Instrument Society of America, William Smith College, Geneva, N.Y., August 3-7.

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Survival of the Fittest

PRESIDENT JOHNSON, on his recent visit to Edwards Air Force Base, lauded the contributions of California to the space and defense effort with the comment that "the nation has needed what California had to give."

The President added: "We will continue to direct our programs to those places where the most effective and efficient work can be done."

This assurance from the President is most welcome. The impact of shifts in the defense market, resulting in layoffs in many areas, has brought once again a demand that consideration be given to depressed labor areas in awarding new contracts.

We strongly believe, as we have stated before, that unemployment is a poor criterion to use in making decisions in the nation's military and space programs.

The President noted that California has 23% of the defense business, more than 50% of the space business and that these percentages are rising. Despite this, there are major areas in that state itself, such as San Diego, which have been hard hit by a falling level of new government business.

Yet, critics continue to point to the concentration of contracts in California and other parts of the nation as though political favoritism were playing a large role in contract awards.

The truth of the matter is that California firms have been aggressive in developing the technology needed to meet the nation's needs. This is true also of firms elsewhere in the nation.

One factor frequently cited in favor of California, and areas such as New England and New Jersey, has been the strong research support of major universities such as California, Stanford, Massachusetts Institute of Technology and Princeton.

Much of the success of firms in these areas, it is stated, results from the support of these major centers of learning. Conversely, the failure of the Midwest to keep up with the sweeping changes in technology is laid to the lack of research interest on the part of nearby universities.

It is rewarding, therefore, to examine the list of grants and contracts, totaling more than $73 million, which went to 139 American universities and colleges from the National Aeronautics and Space Administration during Fiscal 1963. Only three states in the union—South Dakota, Wyoming and Idaho—did not share in this.

It is true that California, Stanford, MIT and Princeton were all in the top 10 in dollar awards. But so were the University of Michigan (2nd place), University of Chicago (3rd place) and University of Minnesota (6th place).

The argument that lack of interest in the Space Age by Midwestern universities is responsible for failure of firms in that area to obtain contracts just does not hold water.

Wailing about lack of university support or crying for political depressed area support ill befits firms in this industry. The free enterprise system works both ways. The company that adjusts to changing markets and technology is the one which deserves to win contracts. The cry-babies we can do without.

For the same reason, we believe that the National Economic Conversion Commission proposed in a bill by Sen. George S. McGovern (D-S.D.) is totally unnecessary. This would result in further government interference in private business. The widespread talk about the necessity of converting this industry to commercial business is just so much pap. There will, of course, be shifts in the space and defense markets. But federal spending with this industry will remain high, regardless of the outcome of the November election. Those firms competent enough to keep up with changes in the market will have no trouble surviving.

ONE OF THE MOST REFRESHING reports on this subject comes from President Walter V. Tyminski of Belock Instrument Corp. Belock is located on Long Island, N.Y., which is experiencing a defense cutback of its own these days. In a speech to a community conference convened to consider this problem, Mr. Tyminski asks: "Did it come about because we are being short-changed in the allocation of defense contracts, as claimed by some, or is the problem more fundamental? My opinion is that the problem is primarily technological in nature."

He proceeds to a sensible analysis of this technological shift, which has affected Belock among others, and proposes some sound steps to meet it.

"I think too that we need some plain talk about the highly publicized 'monstrous' defense cutback, its possible effect on Long Island and the call by some people for the use of political pressure to obtain additional defense business for Long Island," Mr. Tyminski adds.

"If you start with the $50 billion defense budget, you can eliminate from our discussion the $20 billion that is budgeted for salaries and allowances to servicemen and civilian employees. Another $10 billion is not of major concern to us because it covers food, clothing, medicine and other soft goods. Our primary concern is with the Procurement and Research Development Test and Evaluation (RDT&E) total."

The Belock president notes that even if this stabilizes at a $19-20 billion level, this would be at the 1961-62 level of activity and that the net reduction from previously forecast 1970 levels would represent a change of less than 1% of the present Gross National Product, or some $3.3 to $4.3 billion.

"Are we being short-changed on our share of the defense business at the present time?" he asks. "Should we attempt to use political pressure to increase our share of defense contracts? My answer to both questions is an emphatic NO!"

What this industry needs today is more speeches by the Tyminskis and less noise from the cry-babies.

William J. Coughlin

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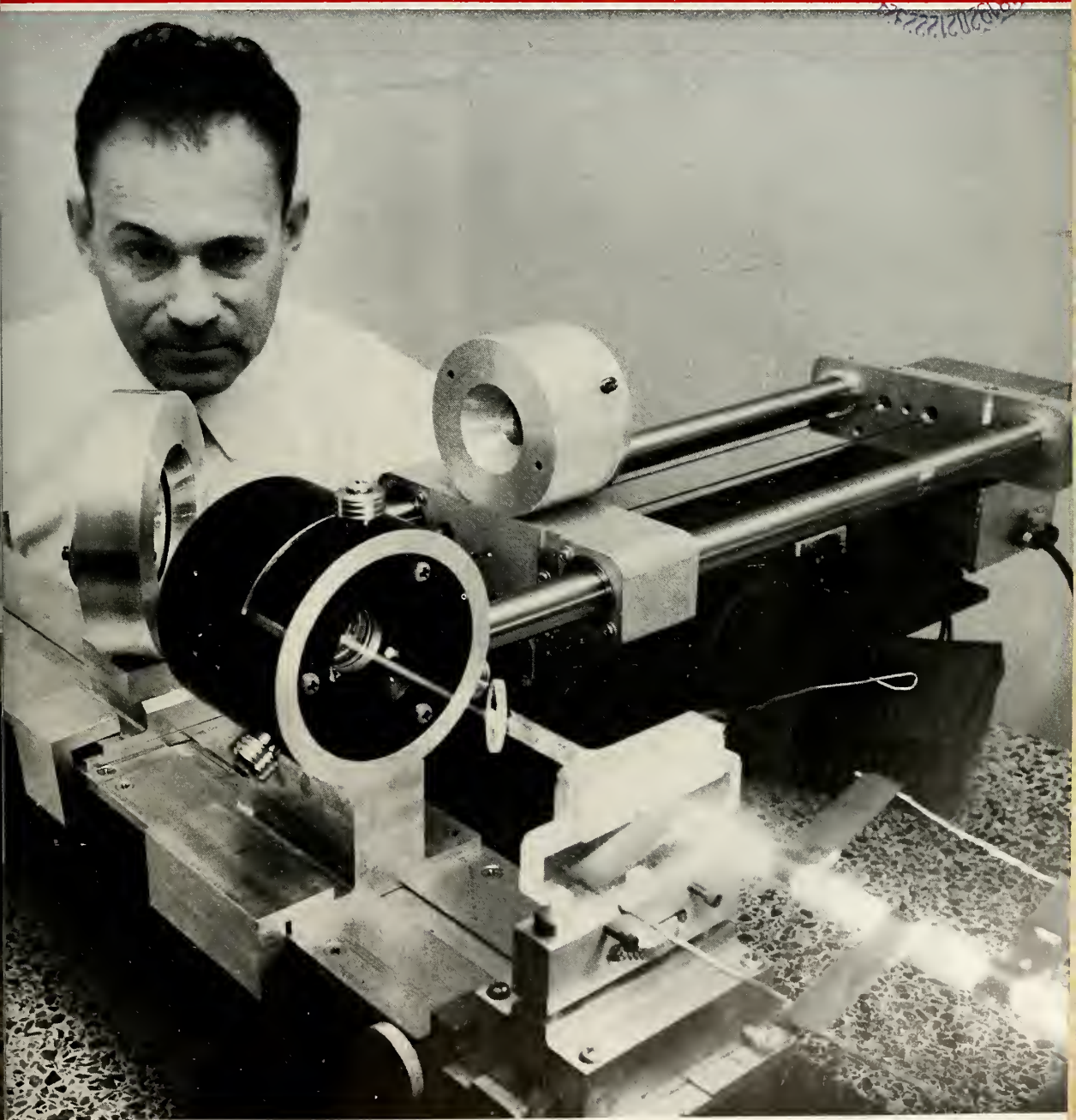
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Volume 15, Number 1 July 6, 1964

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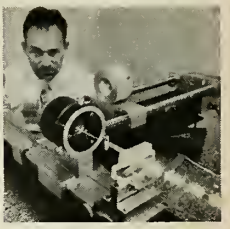
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THE COVER

Gas laser beam is split at exit mirror and half the energy directed to a moving target in AIAA demonstration of Martin Co. concept of doppler laser space navigation device. For a special six-page report on the First Annual AIAA meeting, see p. 12.

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The Surrender Course

To the Editor:

Your several editorials condemning the insanity of unilateral disarmament as preached by certain elements of our foreign policy and defense strategists have served as an inspiration to those familiar with these insidious programs. Not one person in 100,000 has taken the trouble to keep abreast of goings on in this "field."

You might point out in future editorials in this vein that any responsible person can verify your statements by merely sending $.30 to the U. S. Government Printing Office and ordering a copy of State Department Document 7277 and a copy of Public Law 87-297. Careful perusal of these official programs should convince all but the treasonous that all is not right with the Defense and State Departments.

Whether our non-elected leaders have chosen the surrender course by accident, by design, or by ignorance, the time has come for the American people to rise up in their outrage and demand a thorough and penetrating Congressional investigation of these policies and their implementation.

To do this, President Eisenhower's May 17, 1954 Executive Order forbidding cooperation by Executive Branch employees in answering Congressional questions would have to be circumvented—possibly by suitable legislation. This Executive Fifth Amendment is a dangerous roadblock between Congress and the truth. Our intimidated Congress can only stand foursquare if the American people offer some real support for these representatives.

Again, my hat's off to you for your unflinching stance on disarmament and other defense matters. At least one reader is deeply appreciative of the backlash that can result from your position.

S. Deas Sinkler
Chagrin Falls, Ohio

Spacesuit Sealant

To the Editor:

I have just finished reading your article, "Eight Gemini Astronaut Suits Begun" (M/R, May 25, p. 31), which stated that there was a weakness in that oxygen escaped from the zipper closing.

Would it be possible to use an elastic sealant that could be applied to the teeth of the zipper as they mesh and that would have the following properties:

1. Would "set" in a matter of seconds.
2. Would retain its elasticity for a determined period of time, without bubbling.
3. Upon final "setting" or "hardening" would crack and flake/slough off to facilitate unzipping.

If such a product is available and feasible for use, a do-it-yourself squeezetype dispenser could be attached to the handle of the zipper and then removed when the zipper is closed.

Grace B. Cundiff
Cape Canaveral, Fla.

Space and Civil Rights

To the Editor:

Your use of all capital letters in the word "core" ("CORE Delivered for Langley Accelerator," M/R, May 25, p. 25) is the second instance I've noticed of this peculiar misprinting. The subconscious formation of the acronym usually associated with the Congress of Racial Equality is interesting evidence of the pervasive nature of the civil rights problem in this country.

Marvin Cooper
Huntsville, Ala.

Withdrawal Syndrome

To the Editor:

I enjoyed and agreed with your editorial, "Withdrawal from Reality" (M/R, June 15) as I do with most of your editorials.

Particularly, I agreed with your comments on Mr. Stewart Alsop. Perhaps you were a little too kind in your remarks about him.

For example, have you read page 146 of John Stormer's volume, "None Dare Call It Treason"? The book is published by the Liberty Bell Press, Florissant, Mo., P.O. Box 32. $0.75 per copy; quantity prices available. Most interesting.

E. M. Strawbridge
Huntsville, Ala.

To the Editor:

Your editorials have unfailingly irritated me because you strive for the impression of objectivity, yet you always end up with the unsettling conclusion that the sabre offers the solution to the ills of the world. I attributed your position to the fact that your magazine's survival depends upon fomentation of that attitude.

I am no longer irritated. You have explained all by your observation that there may be "some mentally debilitating Russian germ loose in the land" ("Withdrawal from Reality," M/R, June 15, p. 46). . . .

But now I'm frightened. Do you suppose they could be doing it through that damnable fluoridation?

Del Moline
Minneapolis, Minn.

To the Editor:

The editorial, "Withdrawal from Reality," could well be expanded into an article or even a book, in my opinion. This condition is quite widespread, as is shown by the general apathy toward thinking about nuclear war.

D. W. Johnston
Washington, D.C.

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The Countdown

WASHINGTON

Manned Gemini Target Date Slips

Industry sources report that the best target date for the first manned *Gemini* flight is February-March, 1965. It is also believed that the ballistic shot planned for the third quarter of this year will slip into the last quarter. Capsule for that flight won't be shipped to the Cape until Aug. 1.

DOD & CSC: NO Deal?

Proponents of a separate military communications satellite are increasingly encouraged by the continuing lack of agreement between Dept. of Defense and the ComSat Corp. The corporation is more and more unwilling to accept DOD's demand that only a random system will suffice for its needs, and doesn't want to be pushed into a single system at this point. One source predicts that there will be no agreement. He figures the military will get its own system and then, when ComSat satellites become operational, will lease channels for routine traffic much the way it now leases telephone lines.

Big Sparrow Buy Brewing

BuWeps is expected to announce within the next few weeks a major purchase of Raytheon *Sparrow III* air-to-air missiles, for both Air Force and Navy versions of the McDonnell F-4 fighter. Cost is estimated at between $40 and 50 million.

Navy Investigating Air-to-Underwater Missile

The Navy is seriously contemplating a new missile for use by ASW patrol craft. It would be fired from the air after the plane's detection equipment had fixed the location and nature of the submerged target. A recent study has shown the idea to be entirely feasible.

Further Pluto Vicissitudes

Hopes for survival of the Pluto nuclear ramjet propulsion system were raised slightly last week as the Atomic Energy Commission asked for restoration of $4 million of the $5.5 million cut from the project by the House. The request was made in a closed-door session before the Senate Appropriations Committee. The picture darkened again immediately, however, with word from the Pentagon that Dr. Harold Brown, Director of Defense Research & Engineering, had turned thumbs down on the proposal for flight-testing the system designed for the *LASV* vehicle. Apparently interest in disarmament is killing the program.

NASA Money Bill Closely Scrutinized

Chairman Warren G. Magnuson (D-Wash.) of the Senate Independent Offices subcommittee, handling the NASA appropriation, warns that the committee "is taking a mighty close look again this year." The U.S. Chamber of Commerce is asking that almost $2 billion be cut from the total independent offices bill, which covers more than 20 agencies.

Phoebus Groundwork Is Formidable

Three to four years of design, applied research and fabrication work will be required before the Phoebus nuclear reactor for the *NERVA II* engine will be ready for ground testing at White Sands. The reactor will be three to five times as powerful as those used in the Kiwi series.

Ion Powerplant Shot Approaches

First flight test of an ion engine by NASA is scheduled for July 16. It will be launched on a ballistic flight from Wallops Island, Va., using a *Scout* booster.

Target Illumination Studied

A new form of air-ground coordination is under consideration by the Army for destruction of enemy targets. An electromagnetic device on the ground, such as a laser or infrared beam, could be used to illuminate a target; a helicopter or airborne weapons platform would fire a missile that would home on the illuminated area. Marines are also interested in this approach for eventual use with their close-support missile.

INDUSTRY

Gemini Contract May Go Incentive

McDonnell Aircraft Corp. has been asked to submit a proposal to NASA on July 7 as to how its current *Gemini* spacecraft contract can be changed to a cost-plus-incentive-fee award. The space agency has yet to decide whether the upcoming extension of North American Aviation's contract for the *Apollo* spacecraft command and service modules will also be converted into an incentive agreement. NASA now has some 40 incentive contracts worth about $40 million.

Honeywell Building Three Scanners

Honeywell Aeronautical Div., Minneapolis, will deliver three Project *Scanner* spacecraft to Langley Research Center beginning early next year. The project is part of the horizon definition research at the center. The spacecraft will each carry dual radiometers and a radio telescope and will be launched on ballistic trajectory.

INTERNATIONAL

Arabs Dickering for Hawks . . .

Discussions which could pave the way to sales of U.S. Raytheon *Hawk* surface-to-air missiles to Saudi Arabia are now quietly taking place, COUNTDOWN has learned. *Hawk* already is in the hands of Israeli armed forces.

. . . And French Sell Sukarno ENTACS

Latest customer for France's *ENTAC* antitank missiles is Indonesia, now engaged in fighting Britain's ally Malaysia. A large quantity of the weapons are now awaiting shipment from France under considerable secrecy.

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JPL Deputy Named

Maj. General Alvin R. Luedecke, currently general manager of the Atomic Energy Commission, has been selected to direct NASA's unmanned lunar and planetary spacecraft programs at the Jet Propulsion Laboratory.

The retired Air Force officer was named deputy director of the laboratory on June 29. The appointment was announced by JPL Director, Dr. William H. Pickering.

Luedecke's duties at JPL are expected to closely parallel the function of Dr. Robert C. Seamans, Jr., Associate Administrator at NASA Headquarters, who serves as general manager of the space agency.

JPL said officially that Luedecke would be in charge of administrative matters at the laboratory. The general told MISSILES AND ROCKETS, however, that while he will be responsible for most administrative matters, "I also expect to be deeply involved in the management of the *Ranger*, *Surveyor*, and *Mariner* programs."

NASA Administrator James E. Webb recently declared that a hard-headed, business-type management was needed at JPL, and Luedecke has been given the job of installing it. The House Space Committee also recently recommended after an investigation of the *Ranger* program that a deputy director for program management be named at the laboratory.

Luedecke will assume his new duties on August 1.

After more than 25 years in the Army Air Corps and the Air Force, Gen. Luedecke retired with the rank of major general in 1958, when he accepted the Atomic Energy Commission post. As that agency's chief executive and administrative officer for 5½ years, he has directed its varied activities and operations.

NASA Gets $5.2 Billion

Senate and House conferees have agreed upon a $5,227,506,000 FY 1965 authorization bill for the National Aeronautics and Space Administration,—one in which the Senate Space Committee's generosity prevailed over House economies in larger measure than in previous years.

The figure amounts to $33.7 million more than the House approved, and $18.8 million less than voted by the Senate (M/R June 29, p. 15).

Final disposition of the items that were in disagreement:

—Manned spaceflight, advanced missions—Full budget request of $26 million was granted.

—Geographics and astronomy—$3.25 million for the sixth *Orbiting Geophysical Observatory* was restored, but funds for two additional *OGO's* were refused.

—Lunar and planetary exploration—Senate bowed to the wishes of the House in cutting $17.3 million from the *Surveyor* and *Lunar Orbiter* programs.

—Sustaining university program —Senate action cutting $6 million from the request was overturned, and the full budget amount will be authorized.

—Tracking and data acquisition —Half of a $7-million House cut was restored, bringing the total amount available to $261.9 million.

—Construction—Partial restorations of funds cut by the House were made in construction funds available for Ames Research Center, John F. Kennedy Space Center, Manned Spacecraft Center, Marshall Space Flight Center, Michoud Plant, Mississippi Test Facility and various other locations.

—Administrative operations —About half the difference in the two bills was restored.

The conference bill now amounts to a total cut of $76.5 million from the amount originally requested by the Administration.

Fubini Hits 'Gloom Talk'

Defense research and development budgets in the forthcoming years will not change a great deal, a top Defense Department official told a luncheon meeting of the American Institute of Aeronautics and Astronautics.

Attempting to counter the "panic psychology" that has extrapolated a 5% cut in military R&D spending for FY '65 "to very large cuts in the future," Dr. Eugene G. Fubini, Asst. Secretary of Defense and Deputy Director of Defense Research and Engineering warned that such "gloom and doom talk" is bad for the country and, if enough people believe it, a "self-fulfilling prophecy."

In making his prediction that the level of Defense R&D spending would remain relatively constant, Fubini stressed that this conviction was shared by many high officials of the Department of Defense.

Resource allocations to R&D are determined by three factors: the need, the technological progress and the available resources. "Fluctuations will always exist, but it is extremely worrisome to see the public reaction to these decisions by people who should be mature and balanced individuals go so far beyond the cause that creates them as to influence the decisions themselves."

Two areas Fubini singled out as being able "to go up" in spending were aircraft and reconnaissance systems. More money is being spent on aircraft than has been spent since World War II. Fubini challenged industry to apply its imagination and initiative to "a $1 billion weapons system"—the Air Assault Division.

Applying the lessons of Cuba, Laos, Viet-Nam, reconnaissance over unfriendly, but not necessarily enemy, countries is becoming increasingly important, "I am not happy with what we have," Fubini said in citing the need for more work on reconnaissance systems.

With the shift of the balance of power to the United States in the strategic area, DOD must address itself to the situations that are dominated by, but not controlled by, the strategic deterrent. The interests here are not the same as work on penetration aids, advanced guidance systems or the destruction of hardened sites and, although work in these areas will continue, "it is important to see if we can use the same tools to meet the new situations which we face."

Industry, Fubini asserted, should participate in determining the needs of the Defense Department and is "essential as one element" of the decision-making process.

Shots of the Week

NASA's *Centaur* upper stage rocket failed to achieve orbit June 30 when its RL-10 engines cut off prematurely (see p. 10).

- An Air Force *Scout* rocket exploded in flight June 25 while boosting a satellite from Point Arguello, Calif.
- The space agency's re-built *X-15* rocket plane made a successful debut June 25, but on a second flight June 30 had to be shut down early because of guidance equipment failure. Air Force Maj. Bob Rushworth flew the first mission and attained an altitude of 83,000 ft. and a speed of 2,966





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mph. NASA test pilot Jack McKay landed the ship safely after the second flight attempt.

● The Soviet Union on July 1 orbited *Cosmos 34*, the 10th such scientific satellite launch of the year. The satellite achieved orbit and established a period of 90 minutes. It was transmitting on a frequency of 19.-885 mc, according to the official Russian news agency Tass.

Ritchey New Thiokol Chief

Dr. Harold W. Ritchey is the new president of Thiokol Chemical Corp., succeeding J. W. Crosby, who has been named chairman of the board.

Ritchey was vice president of Rocket Operations at the time of the new appointment. Crosby will continue as chief executive officer of the propulsion firm.

H. R. Ferguson resigned as executive vice president, but will continue as a consultant to the firm. Four new vice presidents were also named by the company's Board of Directors last week.

R. E. Davis, currently the Eastern District Office manager, was named a vice president. The others named were C. E. Hunter, general manager of the Wasatch Division; R. L. Marquardt, director of marketing at Rocket Operations; and F. W. Wilson, asst. general manager and director of production, Trenton Division.

MSC Seeks Laser Proposals

NASA's Manned Spacecraft Center has asked industry to submit plans for lasers capable of transmitting from space voice, telemetry and commercial quality television.

Due July 13 are proposals to build a solar-pumped laser that can be modulated magnetically.

Due July 20 are proposals to evaluate three laser techniques: pulse code modulation with polarized coherent light (PCM/PL), pulse position modulation (PPM), and coherent reception. The methods are the outcome of early studies performed under NASA contract by the Hughes Aircraft Company.

The deep space laser communications systems outlined in both RFPs must operate from a mean distance of 50-million nautical miles and provide television reception on Earth of commercial quality.

The contractor must theoretically define the solar-pumped, magnetically modulated laser and build a laboratory model.

An optimized system will be assessed later for its ability to meet MSC's requirements for manned deep space missions.

MSC wants a voice channel bandwidth of 4 kcs, a telemetry bandwidth of 1 kc, and the "equivalent of one commercial quality television channel."

Six-Month Index

AN EDITORIAL INDEX of the articles appearing in MISSILES AND ROCKETS during the first six months of 1964 is available to subscribers free of charge.

Requests for copies should be addressed to:

Research Department
Missiles and Rockets
1001 Vermont Avenue, NW
Washington, D. C. 20005

Centaur Called 'Partial Success'

The technical problem encountered in the third *Atlas-Centaur* flight is not expected to delay the next launch of the liquid hydrogen upper stage now scheduled for September.

Vince Johnson, director of launch vehicles in the Office of Space Sciences and Applications, said that the June 30 *AC-3* launch was a partial success even though it failed to achieve orbit. The stage's two 15,000-lb.-thrust RL-10 engines shut down 127 seconds before their programmed burning time of 380 seconds elapsed.

Johnson said preliminary study of flight data indicates the trouble was in the hydraulic pump drive train, which is used to swivel the engines to maintain flight control.

When the pumps shut down some 4 seconds after *Centaur* ignition, the stage maintained its trajectory, but began to roll.

As the roll increased, the propellant was forced to the side of the tanks uncovering the outlet feeding liquid oxygen to the engine. The engines cut off after 253 seconds of burn time for lack of fuel.

"Since we know where the problem occurred," Johnson said, "we shouldn't have too much trouble correcting it. I don't think it will delay the next launch."

Despite Johnson's optimism, *AC-3* was the second failure in three flights for the *Centaur* stage, now more than three months behind schedule. It could result in further slippage in the *Surveyor* spacecraft due to be launched by *Centaur* in the second quarter of 1965.

Johnson said five flight objectives

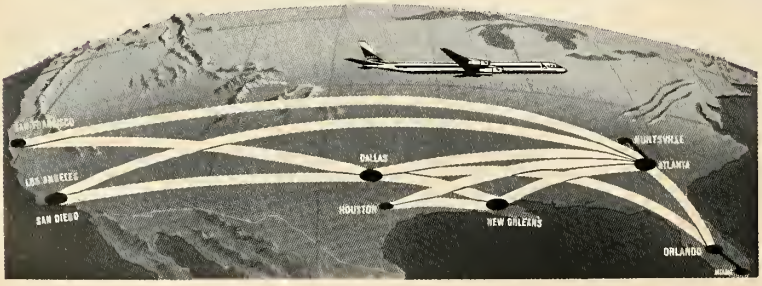
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were attained, including successful jettisoning of insulation panels and nose fairings, separation of the *Atlas* and *Centaur* stages, start and operation of *Centaur's* two 15,000-lb.-thrust RL-10 engines, and demonstration of guidance system operation. Achieving orbit was not one of the primary flight objectives.

AC-3 achieved a maximum velocity of 11,425 mph and an altitude of 345 mi. It impacted the South Atlantic 900 mi. west of the Cape Verde Islands about 2,700 miles downrange.

Rocket 'Smog' Control Sought

A Public Health Service official has recommended that some control should be exercised over organizations testing rocket fuels to prevent a hazard to the public health.

Vernon G. MacKenzie, chief of the Division of Air Polution of PHS, told the Senate Public Works committee that there should be exploration of "suitable means" to insure that test work conducted by private organizations for developmental purposes should be conducted under "suitably controlled conditions."

While the most toxic chemical propulsion systems are proposed for use in upper stages of rockets, MacKenzie said, ground level testing during the development stage "can contaminate the lower atmosphere."

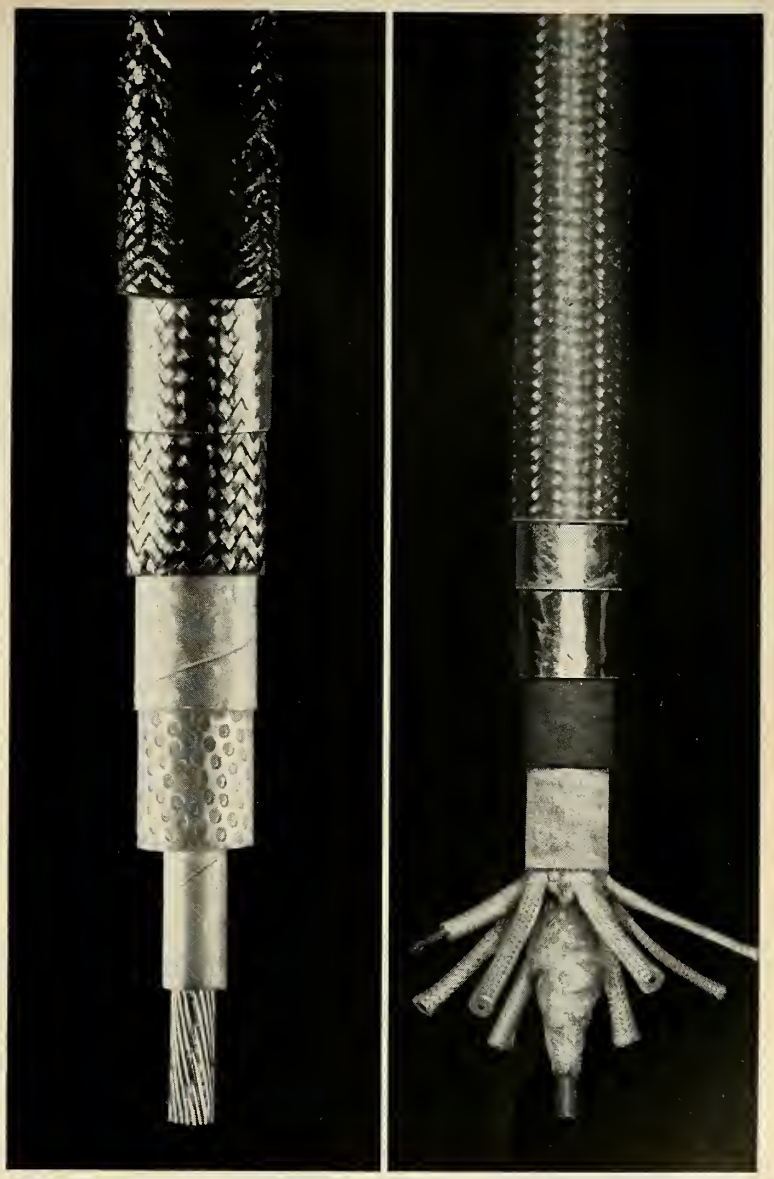
He named beryllium among "the most toxic and hazardous of the nonradioactive metallic substances used in industry today." He said exposure to minute amounts can result in acute respiratory illness, chronic respiratory illness and skin disorders. Inhalation of small quantities has proven fatal, he said.

MacKenzie said that air pollution abatement devices—"gas scrubbers"—have been used in most, but not all, rocket firing or testing operations.

Fluorine also presents problems to both plant and animal life as well as to man, in parts as low as below one part per billion. Conventional gas cleaning equipment for removal of toxic substances does not appear to be sufficient for the very large rocket motors being considered for testing, the PHS officer said.

MacKenzie said that the PHS has "full confidence" that the Federal agencies involved will develop appropriate health protective measures cooperatively and will apply them in all instances of test or full-scale use of these rocket fuel components "insofar as these are under the direct control of Federal agencies."

NASA and Department of Defense medical officials also reported to the subcommittee on extensive safety measures being undertaken by their agencies.



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Institute Urged to 'Sell' Space

President Perkins tells first annual meeting of merged aerospace group it must act to solve problems; technical developments reported in all fields at well-attended sessions in nation's capital

THE NEW PRESIDENT of the American Institute of Aeronautics and Astronautics has warned the members of that organization that they must work harder to promote public understanding of the need for national space programs.

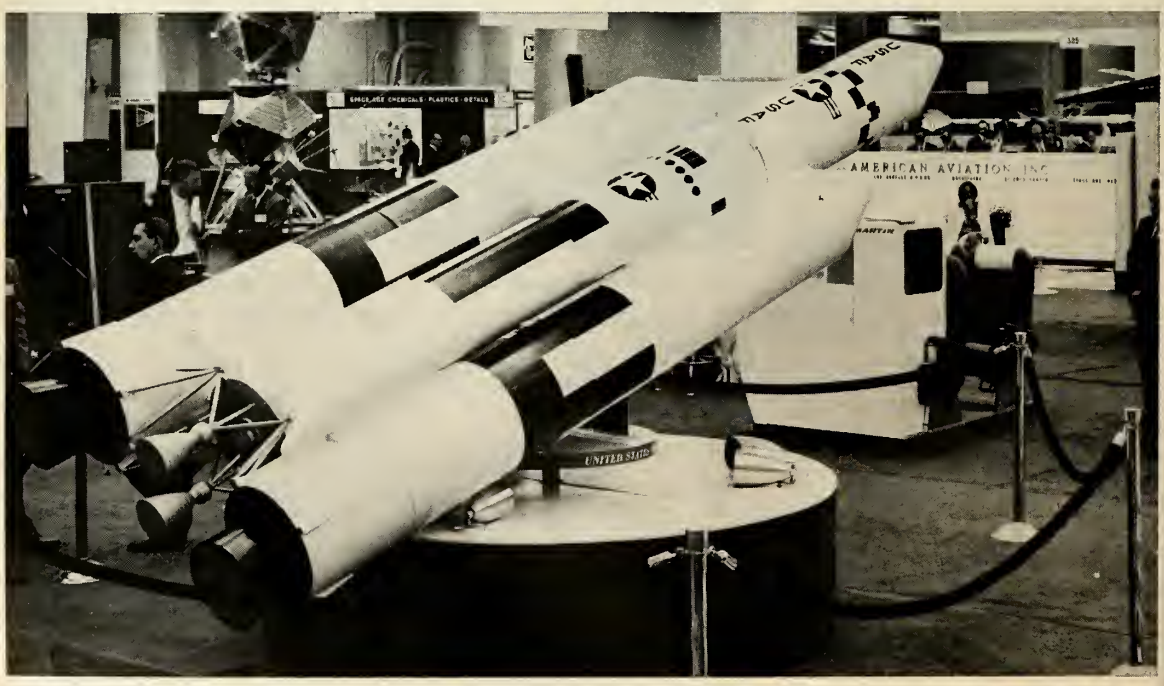
In an opening-day address to the AIAA's first annual conference and exhibitioin in Washington last week, President Courtland D. Perkins declared that the 32,000-member Institute should not fear innovation. After nearly 17 months of merged existence since it was formed from the American Rocket Society and the Institute of Aerospace Sciences, he said, the AIAA needs and must now develop the image of a great society.

The Princeton University professor stressed the fact that there are neglected fields in all of the missile/space disciplines which demand the stimulus available from such a "sound professional society."

● **Leadership lacking**—The manned lunar landing program has been the subject of much debate, some of it by distinguished scientists, Perkins noted, but AIAA has never examined the issue. Similarly, the society has not provided leadership in the case of the supersonic transport. And it has left the fight for manned spaceflight to a few NASA and military leaders.

Impressive statistics on papers published, technical committees in existence, meetings and memberships are not of themselves important, Perkins observed. What is important, he said, is a "self-renewing" organization. Perkins urged that the AIAA define its goals and provide a forum for discussion of the major problems of the industry. He further recommended that technical areas now largely ignored be made the subject of new panels and special conferences.

● **Exhibits a success**—Eighty-one exhibits, largely designed for just this show, provided an impressive array of aerospace hardware and systems to enthusiastic viewers. The displays filled the three large exhibit areas in the Sheraton Park Hotel; however, the arrangement of the unusually large indi-



VIEW OF AIAA exhibit hall shows model of Martin Co./Air Force Titan III-C (foreground), full-scale model of TRW Space Technology Labs' tandem-launched nuclear-detection satellites (left rear), first launched from Cape Kennedy Oct. 16, 1963.

vidual exhibits was such as to provide viewers with a feeling of spaciousness and freedom of movement.

The AIAA's decision this year not to open the exhibit area to the general public also helped provide an uncrowded atmosphere for registrants.

Fifty-four of the 243 scheduled lecture-demonstrations presented by exhibitors were held on the first day of the June 29-July 2 meeting. As anticipated, some noise problems were created by the loudspeakers during such lectures, but this was later largely corrected by AIAA officials.

Most of the industry booths were staffed primarily by top engineering talent. Project engineers and project managers were often on hand to provide details on their firms' status in specific national aerospace programs.

● **Attendance up**—More than 2,700 registrants had checked in by mid-day Tuesday.

Two technical areas, reliability and maintenance, were not covered during the AIAA meeting. These subjects were presented in detail, however, at an AIAA/SAE/ASME-sponsored Aerospace Reliability and Maintainability Conference held concurrently at Washington's Statler-Hilton Hotel.

Also, a special meeting covering Legal Socio-Technological Problems of Space Exploration was held July 2. The colloquium was held in conjunction with the AIAA meeting by the U. S. Air Force Judge Advocate General's Department Reserve at the State Department Building. The all-day program consisted of four panels. Panel members included many of the nation's top private and government lawyers, law professors and aerospace leaders.

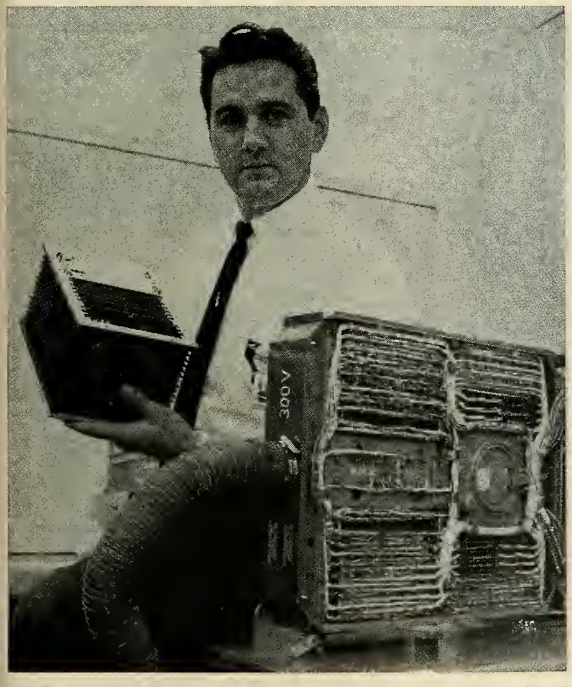
In the following pages, M/R editors have selected a few of the many technical highlights presented at the meeting —new systems, new techniques, new advances in space electronics, propulsion, materials and life support.

SPACE ELECTRONICS

Described as "the smallest real-time computer yet made," a 13-lb. digital system called the D26J-1 was unveiled at the meeting by Autonetics Div. of North American Aviation, Inc. Although classed as a general-purpose computer, its main use is seen in guidance and control.

The computer is part of Autonetics' Monica program, a large family of microelectronics computers the company has in production development. (The word Monica as an acronym has no meaning today. The company uses it simply to refer to a technology of microelectronics gained out of company-funded work as well as out of the *Minuteman* program).

In part, the D26J-1 computer technology was derived from the D37B, the first microelectronic computer ever to be put into a missile guidance system. The D37B is the guidance computer for the Advanced *Minuteman* missile. The first units are just now being installed, and shortly they will be ready to undergo their first firings.



NORTH AMERICAN AVIATION'S Autonetics Div. introduced its D26J-1, the smallest in the Monica family of computers.

Smaller than the D37B and needing only 50 watts of power to operate, the D26J-1 has a 500-kc clock rate. The unit measures 5 x 6.5 x 13.5 in. and can be stored in 0.15 cu. ft.

● **Compact unit**—Claiming that the D26J-1 is a "significant advancement in computer technology," program manager Mike Rebich said at a press briefing before the AIAA meeting that "reliability and compactness (are) combined with modular flexibility." Illustrating this, Rebich noted that some of the semiconductor integrated circuits contain the equivalent of 45 discrete components. "They are packaged into a tiny silicon wafer less than 0.04 square inches in area. More than 90% of all the D26J-1 digital circuits are accommodated by these small and highly reliable components."

The contributions to microelectronic technology claimed for this newest computer lie in the integrated circuitry, memory and the technique for making the multilayer board for the memory.

The D26J-1 computer uses ten layers of boards, each with integrated circuits mounted on both sides. In this way, they provide a solid wire harness as well as the ability to shield against coaxial cable effects, when necessary.

The system is cooled by running the heat through conductors to the edges of the multilayer boards and out the computer container.

● **Modular design**—"Another design decision," said Rebich, "was to build each computer as a module or building block for use singly or combined with other computers to provide increased computational capacity and redundancy."

The versatility of the D26J-1 extends to all its subsystems such as the arithmetic, memory and input/output, which are all modular and "can be adjusted to meet system requirements without major redesign."

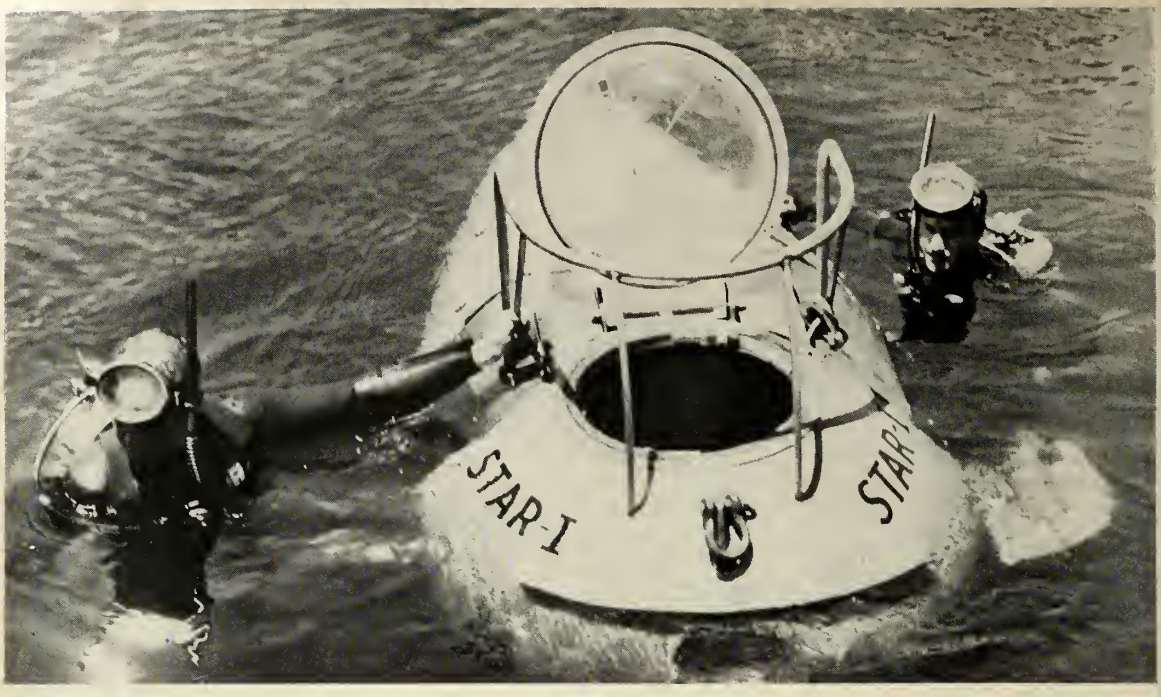
In a listing of the specifications for the computer, Autonetics says that word length, memory capacity, and input/output capability can be tailored to meet specific requirements; for example, memory capacities can be expanded from 1,024 to 16,384 words with a 12- or 16-bit word length, respectively.

The 12-bit instruction version is said to be able to perform arithmetical functions with either a 12- or 23-bit accumulator. The 16-bit instruction machine is said to accommodate data with either 16 or 31 bits including sign. Inputs and outputs available are shaft, incremental, resolver, voltage, discrete character and whole word.

● **ComSat control**—An internationally-oriented Interim Communications Satellite Committee is being drawn together to serve in the establishment of broad policy and as an operations monitor for the young Communications Satellite Corporation.

The 12-man "board of directors," John Johnson, a chief foreign negotiator for CSC, disclosed to a space-law session on Tuesday, also will have the power to approve all major contracts awarded by CSC. The interim committee will serve through 1969. A permanent committee will take over on Jan. 1, 1970, under the present plan.

Looking to the future global system, Johnson predicted that the U.S. will certainly provide over 50% of the total



STAR I, described by owner General Dynamics/Electric Boat Div. as the world's first submersible powered by a fuel cell, about to undergo trial near Groton, Conn. AIAA registrants saw the fuel cell, developed by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

investment. European nations, he said, will account for about 25%; Canada, Japan, and Australia together will have another 8%, and some 17% will be held in reserve for other new participants. The investments, he pointed out, also represent the ownership voice held by the participating countries.

Global communications network negotiations, said Johnson, are inherently difficult since ComSat officials are dealing at present with the U.S. and 17 other nations. Only Japan and the U.S. are represented by commercial firms in this enterprise—the rest are either government-owned corporations or government-agency representatives.

● **G&N survey**—DOD funding in Fiscal Year 1964 totalled about $1.175 billion for guidance, control and navigation, according to an estimate by Cmdr. R. C. Duncan. In this survey paper of the State of the Art in Navigation, Guidance and Control, the chief of NASA's guidance and control division, Manned Spacecraft Center, Houston, pointed out that half the R&D expenditures are for inertial guidance systems alone. The remainder is for command guidance, satellite navigation systems and the like.

But he stressed that 80% of all G&N production expenditures are for inertial systems. The reason, said Duncan, is due to the very high unit cost of inertial systems even in large-scale production.

In a breakdown of expenditures by military service, Duncan reported that the Air Force, with 61% of the total G&N budget, is spending 87% on inertial systems. Navy splits its funds (25%) about evenly between inertial and non-inertial, and the Army (14%) funds are largely for non-inertial systems.

SPACE PROPULSION

A pair of nuclear propulsion systems using magnetohydrodynamic devices to transfer energy from the reactor to the propellant may result in specific impulses an order of magnitude over the best in chemical systems.

Dr. Arthur Kantrowitz, director of the Avco-Everett Research Labs, described the systems in the Von Karman lecture. The approach does not rule out the development and application of *NERVA*-type systems in the interim.

Kantrowitz says *NERVA* should be used until something better comes along, since it has twice the performance of chemical systems.

● **MHD as a tool**—One of the two proposed configurations is comparable to the gaseous-core reactor system. It uses MHD to transfer the energy from the primary reactor-heated cycle to the propellant. The fuel container can have walls at temperatures within the capabilities of existing materials.

The energy interchange at low temperatures is through an ordinary heat exchanger. High-temperature energy exchange would be electrical.

The other approach involves a gaseous-core reactor cycle using a high-temperature radiator. The system would employ a gas turbine cycle, with both compressor and turbine functions being handled by MHD accelerators and generators. All of these devices would be small compared to the radiator—which would be at the material's highest possible working temperature.

The Avco expert said recoverable boosters would be one immediate result of the MHD approach, because fuel weight and bulk would no longer be large with respect to other portions of the space vehicle.

It would also obviate the current practice of optimizing launch weight at the expense of everything else in the vehicle design. It would no longer be necessary to live with some of the more critical aspects of a launch trajectory.

The MHD route would dramatically decrease the cost of planetary missions.

Kantrowitz described what he called two dummy objectives to stimulate research into plasmas. He said he hoped both would bear fruit, but the knowledge gained would be worth the quest in any event.

First of these, he said, is the ability of plasmas to handle high-temperature gases and large amounts of power, which may lead to using the full potential of nuclear energy.

The next feature, says Kantrowitz,

is the vast area of unknown territory in high-temperature plasmas with the equally large lack of fundamental physical understanding.

Experts from United Technology Center and Lockheed Propulsion Co. covered the various aspects of current technology in hybrid rockets. W. Nachbar of Stanford University covered the systems in a survey paper, but concluded that the overriding disadvantage of hybrid systems is the advanced development status of both liquids and solids.

The Stanford associate professor claimed that, in any given application, any improvement offered by the hybrid system over the best liquid and solid contenders will seldom justify the additional development cost. An expansion of hybrid technology is needed before the hybrid rocket promises of improved performance and controllability with storable propellants can be fulfilled, says Nachbar.

● **Variable burning solid**—Gerald Golub of Martin/Orlando defined the need for a variable burning rate solid propellant to cover various applications. The approach would alleviate the time-consuming and expensive proposition of designing a solid-propellant formulation for each application as it comes along.

A method of collecting liquid propellants in a zero-g situation through electric fields was covered by J. B. Blackmon of Douglas Aircraft Co. The analysis involves use of the concept of dielectrophoresis in a 250,000-lb. space vehicle powered by LH_2-LOX. The conclusion is that the electrical approach weighs only 1/10 of a comparable auxiliary propulsion system. The power requirements are on the order of 10^{-2} watts.

There were several papers concentrating on the design and analysis problems posed by the use of ablatives in both nozzle and thrust chamber applications. One representative presentation by Sanford J. Tick and George R. Huson of Thiokol Chemical Corp.'s Reaction Motors Division discussed the development of analytical techniques in predicting the quantitative behavior of ablative materials. The predicted and actual results were in agreement.

● **Solid abort method**—Aerojet-General's R. F. Cottrell described a unique safety system for large solid boosters in manned flights. The technique uses two layers of electrically conductive rubber in the case insulation to detect burn-through.

The detection circuit's other section is a tungsten probe located anywhere in the rocket chamber flame zone. If the insulation is burned through prematurely, the first conductive layer acts to close the circuit and warn the astronaut. When the second layer is penetrated, the astronaut takes immediate steps to abort the mission if the boost-phase time cycle cannot be met.



SELF-SEALING material being developed for Air Force by Hughes was on display, showing how space "blowouts" may be repaired. Jagged path shows exit path of pellet.

The Aerojet system also includes a water-quench sequence to slow and eventually extinguish the reaction in the booster chamber. This allows time for adequate destruct mechanisms to function and avoids a booster explosion.

There are numerous means to check out the system before loading propellant, and the rubber layer addition to the case insulation is compatible with the manufacturing and lay-up processes currently under development (M/R, May 25, p. 26).

Experimental runs with a 10-lb., 800-lb.-thrust motor have demonstrated the technique with the proprietary General Tire conductive rubber composition. In addition, data obtained indicate it may be possible to see a significant increase in conductivity as the flame approaches the layer—adding an even greater detection ability.

Power requirements are extremely low and the cost is almost negligible compared to the total insulation task in a 260-in.-dia. booster. The method can be usefully employed as another evaluation technique in solid rocket development.

The procedure covers only burn-through—caused by cracks in the propellant or faulty insulation, for example. Pressure fluctuation detection can be

AIAA Hears of Soviet Weightlessness Concern

SOVIET DOUBTS about man's ability to survive in extended weightlessness were again reported by Dr. Bernard Wagner, New York Medical College cardiovascular expert, who has conducted extensive communications with Soviet space medicine experts.

Wagner, who was scheduled for general talks to the AIAA on bio-astronautics, departed from his text to discuss conversations he had recently with Dr. Vassily Parin, Soviet space medicine chief. Parin, he reported, said that the Soviets feel that astronauts may not be able to survive more than 14 days in zero-g because of cardiovascular de-conditioning, which would make their safe return to Earth impossible. The Soviets seem to feel that artificial gravity will be necessary.

Parin also disclosed that the Soviets may use primates in future missions although dogs remain chief research subjects.

handled by other means.

ADVANCED MATERIALS

The friction drag on missile-like shapes dropped into a water tank was cut nearly a third by applying non-Newtonian soluble coatings on the body's nose. If these laboratory results can be duplicated on underwater operational devices, significant advantages are foreseen: speed of torpedoes can be increased without changes in the powerplant; the drag hump of a hydrofoil boat can be cut, thereby cutting the size of the craft's powerplant; the speed of landing craft approaching a beach can be decreased, thereby decreasing the exposure of men and equipment to enemy fire.

The experimental studies, performed by S. Thurston and R. D. Jones of the Northrop Corp., were made while the men were working for Astropower, Inc., a subsidiary of Douglas Aircraft Co. They reported that their results are "sufficiently encouraging to recommend an accelerated program and extension to larger scale tests" in their paper, "Experimental model studies of non-Newtonian soluble coatings for drag reduction."

Typical fluids that exhibit Newtonian behavior are water, oils, varnishes, syrups, and petroleum products. For these, the ratio of shear stress to the rate of shear is constant. In other words, Newtonian fluids exhibit linearity between velocity and pressure loss while non-Newtonian fluids exhibit nonlinearity. Examples of non-Newtonian fluids: colloids, emulsions, polymer suspensions and some organic materials.

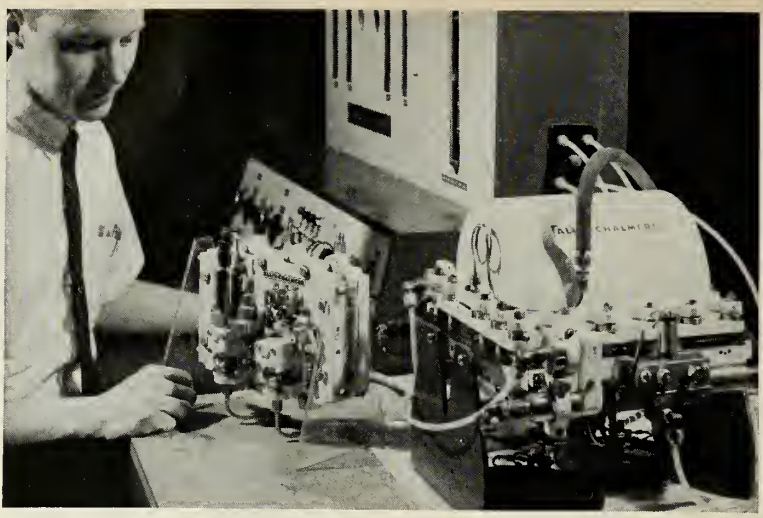
● **Refractories**—The whole field of refractory metals was discussed in a critical manner by Harris M. Burte and a group from the Air Force Materials Laboratory, Wright-Patterson AFB, Ohio.

After a highly detailed assessment of the characteristics, fabricability and future research trends of columbium, molybdenum, tantalum and tungsten, the Air Force specialists conclude the time has come for boldness in prototype hardware development.

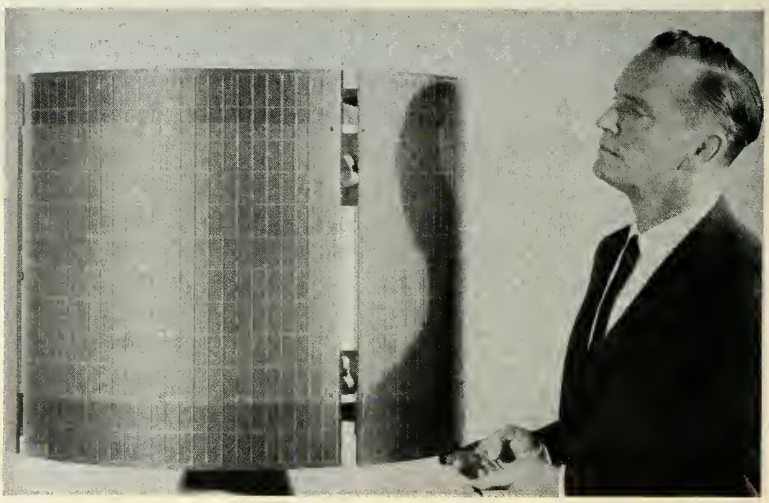
Especially crucial is the need for flight-test vehicles to allow advancements in the technology of coated refractory metals for vehicle thermal protection systems.

In another vein, the authors admit the difficulty of predicting poundage use except to indicate that more material may be consumed in experimentation and property data generation than in actual hardware construction.

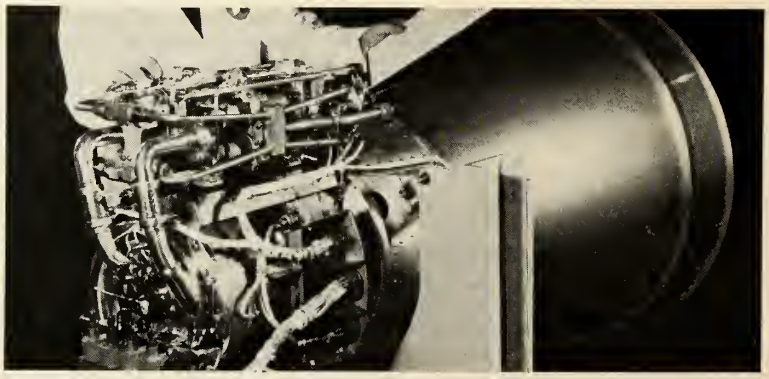
● **Uncooled nozzles**—Sidney Elkind of Arde-Portland, Inc., described a feasibility study into the design and fabrica-



ALLIS-CHALMERS' small (14 lbs., 9 oz.) fuel cell, capable of producing up to 50 watts electrical power, was shown publicly for the first time at the AIAA meeting. It is reportedly scheduled to be flight-tested soon in an Air Force satellite.



FULL-SCALE model of first communications satellite to be built for Communications Satellite Corp. by Hughes Aircraft Co. was shown at AIAA exhibit. It is an improved version of the Hughes/NASA Syncom. First launch is scheduled for 1965.



MOCKUP SHOWS final full-scale configuration of Lunar Excursion Module's ascent engine, being developed by Textron's Bell Aerosystems Co. for Grumman Aircraft Engineering Corp. Engine, developing 3,500 lbs. thrust, will lift LEM from Moon.

tion of an uncooled nozzle for a 20-minute firing.

Such nozzles will have to be developed for the nuclear rocket. The thermal problems are considerably different from those in chemical powerplants.

For instance, according to Elkind, the nozzle must tolerate gamma heating during both operating and shutdown periods as well as the normal propellant gas temperature and pressure problems.

Design requirements have been met by a shielded composite wall structure using tungsten, graphite, pyrolytic graphite and René 41. Elkind found that effective thermal material is required to insulate the outer structural shell from the internal core gas. The combined effects of this insulation and gamma heating results in a hot side wall temperature above that of the gas. The gas thus cools the wall, and the temperature of the structural shell depends directly on gamma heating. It is not affected by either core-gas temperature or pressure reduction.

J. A. Fager of General Dynamics/Astronautics detailed the development of the titanium alloy 5 Al-2.5 Sn Ti for liquid-hydrogen tankage applications. The alloy is said to be a major contender for flying tankage because it is 35% lighter than comparable aluminum and steel alloys, more crack-resistant and the annealed form can be readily fusion welded. The material is available in thin-gage coil stock and has been successfully fabricated in 10-ft.-dia. tankage components.

Cork thermal ascent insulation in the *Minuteman* program was detailed by Robert Hovey of TRW Space Technology Labs. J. W. Huffman and R. H. Johnson of North American Aviation described the evaluation and use of Emerson Electric's Thermolag T-500 on the new *X-15*.

LIFE SUPPORT

A self-sealing space capsule developed for the Air Force was shown by Hughes Aircraft Co. The technique, which would prevent explosive decompression in manned space capsules, uses a chemical sealant in the laminated spacecraft walls.

If a meteorite hit the chamber walls, Hughes materials scientist Arnold J. Tuckerman said, it would trigger a chemical action. The material would foam immediately, then harden into an air-tight solid mass, sealing the hole. Materials used are polyurethanes and polyamide prepolymers. They could prevent air leakage for as long as two weeks.

● **Astronaut protection**—Dr. Carl Clark of the Martin Co. discussed an airbag restraint and impact protection system being developed for NASA's Office of Biotechnology and Human Research.

The company used a *Mace* warhead section shipping container about 6 ft. in diameter and 12 ft. long to simulate the space vehicle. Crash bars were installed and the box was reinforced. Two hemicylindrical bags are placed above and below the astronaut, with smaller cylindrical bags above his head and below his feet.

After preliminary testing with an anthropomorphic dummy, several manned crash simulations were conducted. Clark said that preliminary tests under vibration and impact show the conceptual feasibility for spacecraft, as well as for passenger aircraft and automobiles, although many engineering details must still be solved.

● **Astronaut retrieval**—Marquardt Corp. and Langley Research Center engineers reported on a study of methods to retrieve astronauts from extravehicular space, which was conducted for NASA.

Within certain limits, tethering will be sufficient, the researchers said. For most cases, however, "non-conservative" approaches must be used. These will involve either multiple-body deployment or some form of thrusting. In all situations, the group said, a flexible cable joining the astronaut to the space vehicle offers the most advantages.

While flexible connections in space have been treated lightly in the past, the researchers say they do offer the best solution to this problem as well as for other missions—such as docking of logistics vehicles with space stations, or the safe handling of a radiation source in space, or maintenance tasks.

The researchers said that various techniques could be developed to allow partial reel-in and circularization of the tethered mass for retention and capture. Most satisfactory of the methods discussed would be one in which the system provides momentum dissipation during retrieval, while the most efficient would be one using thrust applied at the smaller mass, presumably the astronaut.

● **New simulator**—North American Space and Information Systems Division exhibited a model of the new $310,000 rotational device that will be completed by the company at Downey, Calif.

The company said that research engineers will remain in the rotating craft for studies of two weeks and longer in an effort to study man's reactions to gravity artificially induced by rotation.

The beam will give the facility a diameter of 150 ft., but may be extended to 250 ft. in later tests. Two modules, modified KC-97 cargo planes, are being constructed to simulate space-station living quarters. These modules will be 10 ft. in diameter, 40 ft. long and weigh as much as 20,000 lbs. fully loaded.

The project is company funded. North American's Life Sciences department will work partly from data accumulated during two rotational research tests at the University of Southern California, in which three men spend three days and nights rotating at the end of a 23-ft.-radius arm.

● **Rotation susceptability**—NASA Langley Research Center scientists told the AIAA that a number of tests up to 10 rpm demonstrated the variation in response of subjects, all with normal semicircular canal systems.

Some of the subjects could tolerate the high rotational rates, and probably would be able to adapt in space station conditions, the researchers indicated. Others could not tolerate various combined motions of the head. The group concluded that adaption to rotation would be more readily obtained therefore if the head was moved so as not to stimulate the lateral canals by cross-coupled accelerations. More study is needed, they said.

● **Dual role for tanks**—The possibility of using the same tanks used for spacecraft fuel for life-support uses was propounded by C. J. Swet, senior staff engineer at Johns Hopkins University Applied Physics Laboratory. Swet said that multiple use of liquid propellant combinations such as hydrazine and hydrogen peroxide could reduce spacecraft weight considerably.

Large quantities of drinkable water and oxygen and nitrogen in selected ratio would be available from oxidizer-rich combustion of such propellants in a gas generator, he said. And the released heat and kinetic energy from the reaction would further be available for electric power generation, temperature control and variety of mechanical functions.

A "psychologically acceptable" method of washing astronauts was reported by General Dynamics Electric Boat Division, which conducted a study under a contract from Langley Research Center. The group recommended benzalkonium chloride (BAC), a germicidal and detergent compound in solution. This was tested on two subjects for several weeks. No rinsing was needed.

The researchers said that wash water could be recovered using a particulate filter and activated carbon and ion exchange resin beds in series. No viruses remained in the water using this system, they added. ■

McNamara quickly rebuts . . .

Republican Body Charges DOD, LBJ With Planned Weapons Obsolescence

by Heather M. David

HOUSE REPUBLICAN LEADERS and Secretary of Defense Robert S. McNamara clashed again last week over defense policies. The GOP spokesmen charged that the Administration has built into the military establishment "planned obsolescence" and a "decline in innovation."

The House Republican Policy Committee "Task Force on American Strategy and Strength" charged that the Administration "has allowed the decisive edge of American military superiority, bequeathed to them by the Eisenhower Administration, to be blunted."

The group, led by Rep. Gerald Ford (R-Mich.), a ranking Republican on the Defense Appropriations Subcommittee, called for highest priority for these areas:

—Development of a new generation of strategic *manned* weapons systems for missions either in the Earth's environment or near space and full exploration of the military implications of outer space.

—Assignment of top priority to development of an anti-ballistic-missile defense system.

—Transformation of propulsion systems, especially in the forthcoming attack aircraft carrier, from conventional to nuclear power.

—Establishment of a comprehensive anti-submarine warfare program, "ranging from the most basic studies in ocean sciences to the production of end-product hardware.

● **DOD answer**—Secretary McNamara immediately answered the accusation with a statement which said in part that there has been a "50% increase per year in the total funds expended on research and development over that prevailing during the last four years of the previous Administration." He added that there have been 208 new projects, including 77 weapons programs costing more than $10 million each. Among these he included the "medium-range ballistic missile."

Anti-submarine warfare programs have increased 54% in the Fiscal 1965 budget request over 1961, he said.

● **R&D gap**—The GOP group scored the Dept. of Defense for failing to develop an oncoming generation of manned strategic systems for the seventies as the "most signal aspect" of the R&D gap."

"The missile systems to which the Administration would trust the entire strategic deterrent were all developed under the Eisenhower Administration, with no strategic missile system being added or imminent under the current Administration," the report charged. This "planned obsolescence," the group said, will put the U.S. in second place.

Missile systems such as the *Polaris* and *Minuteman* "have not been tested sufficiently with nuclear warheads to prove reliability," the group added. Thus, the downgrading of manned systems destroys the "balance of defensive posture," it said.

● **ABM lack**—The "failure to develop and deploy both 'active' and 'passive' missile defense systems" has had an adverse effect on deterrent capability, according to the group.

The GOP group also said that the "known" hardening of Soviet strategic strike forces could result in "destabilization." It termed "doubtful" the United States' ability to refine yield-to-weight ratios in large thermonuclear warheads "to the point where they could be reliably delivered by new manned or unmanned systems under the terms of the nuclear test ban treaty."

● **NATO changes**—The report also called for reconstruction of the North Atlantic Treaty Organization, including the exploration of plans for nuclear sharing among the Big Four. It scored the Administration for its handling of the *Skybolt* affair, as being part of the what the GOP called the "Why Win?" policy of the Administration.

The group also attacked the fact that the Administration "ignored" suggestions by Gen. Lauris Norstad and others that mobile, land-based medium-range missiles (*MMRBM*) in Western Europe would be more practicable than *Polaris*-equipped merchant ships. ■

LBJ Seeks New NATO Agreement

PRESIDENT JOHNSON has laid before Congress a proposed new agreement that will allow the North Atlantic Treaty Organization (NATO) and its member nations to receive information on nuclear weapons employment and effects. Such information has hitherto been restricted to the NATO headquarters groups and countries with which the U.S. had negotiated individual agreements.

Superseding a 1955 pact, the new agreement was justified on both military and political grounds. "It is needed to enhance the effectiveness of NATO defense," the President's message said. "On political grounds, it is needed to reinforce NATO cohesion by meeing our Allies' legitimate desire to make a constructive contribution to nuclear defense."

The agreement, which is classified Secret, is designed to accomplish two goals:

—"It will extend the types of information which we can exchange with NATO. This expanded area of information is needed to enable our allies to make effective use of nuclear delivery systems being provided them" under various agreements.

—"It will permit NATO member countries to share in information which the United States has hitherto been exchanging only with the NATO organization itself under the 1955 agreement. This will make these countries' role in alliance planning in the nuclear field more effective."

The agreement was referred by both houses of Congress to the Joint Committee on Atomic Energy, which is expected to examine it in some detail.

Unless the House or the Senate passes a resolution disapproving the NATO-U.S. pact, the agreement is effective after 60 days during which Congress is in session. With the national political conventions at hand, however, and early adjournment of Congress expected, the agreement may not become effective before next year.

Until this agreement, Britain, France, West Germany, Canada, Belgium, the Netherlands, Greece and Turkey were the only countries receiving such data under bilateral arrangements with the U.S.

Third Manned Gemini Will Have Rendezvous Capability

by Rex Pay

HOUSTON—The Manned Spacecraft Center has decided that the third *Gemini* two-man orbital flight *(GT-5)* will

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about 20 n. mi., and the *Gemini* will be overtaking the *Agena.* When some 20 mi. behind the *Agena, Gemini* will start the rendezvous operation.

This will not be a minimum-fuel maneuver, or Hohmann transfer ellipse, but will be a direct nulling of position and velocity differences between the two vehicles, either manually or with various degrees of automatic assistance (M/R, Aug. 19, 1963, p. 36).

An advantage of the concentric method is the relatively short distances

Agena engine. No re-burn to achieve a perfectly circular orbit is planned.

If the *Agena* orbit is slightly elliptical, the aim will be to go for a *Gemini* "circular" orbit of the same ellipticity, with the same line of apsides.

● **Alternatives**—One other method of rendezvous considered was to inject the *Gemini* first into an elliptical orbit having an 87-mi. perigee and a 161-mi. apogee. With the *Agena* again in a 161-mi. circular orbit, there

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Third Manned Gemini Will Have Rendezvous Capability

by Rex Pay

HOUSTON—The Manned Spacecraft Center has decided that the third *Gemini* two-man orbital flight *(GT-5)* will have the capability of rendezvous (M/R, April 13, p. 22). A rendezvous method has been selected and the Center is now studying whether the exercise will be carried out on *GT-5* or *GT-6*.

"We have decided to go on the concentric orbit method" said Christopher C. Kraft, MSC's Assistant Director for Flight Operations. He explained that this was one of three methods that had been studied in recent months.

Rendezvous is, of course, essential for the *Apollo* lunar mission, because the Lunar Excursion Module must rendezvous with the Command and Service Modules to get back to Earth.

Demonstration of rendezvous and docking, and gaining of proficiency in this space operation is one of the two major mission objectives of *Gemini*.

● **Parameters**—The concentric orbit method will mean the simultaneous countdown of the *Atlas/Agena-D* target vehicle and the *Titan II/Gemini* two-man spacecraft. The schedule calls for the *Atlas* to be launched first, with the *Agena* injected into a circular orbit at about 161 nautical miles altitude. On the first orbital pass of the *Agena* over the Cape area, *Titan II* must inject the *Gemini* spacecraft into a coplanar elliptical orbit with a perigee of about 87 n. mi. and apogee of 141 n. mi.

Any delay in the *Titan II/Gemini* countdown that prevented launch at the correct time would slip the rendezvous attempt two days.

If the spacecraft is put directly into its planned elliptical orbit, rendezvous will be accomplished some six hours after lift-off (three and a half orbits).

First maneuver will be to circularize the *Gemini* orbit. The vertical distance between orbits will then be constant at about 20 n. mi., and the *Gemini* will be overtaking the *Agena*. When some 20 mi. behind the *Agena, Gemini* will start the rendezvous operation.

This will not be a minimum-fuel maneuver, or Hohmann transfer ellipse, but will be a direct nulling of position and velocity differences between the two vehicles, either manually or with various degrees of automatic assistance (M/R, Aug. 19, 1963, p. 36).

An advantage of the concentric method is the relatively short distances involved. Also in its favor is the fact that the spacecraft always approaches its target from the same angle. Furthermore, it is relatively easy to ensure that the target vehicle is seen against a star background during rendezvous, and the rendezvous can be made to take place over a suitable point on the Earth's surface—one providing a good data link with the center here.

From the point of view of overall probability of mission success, the method has another dividend: the rendezvous can still be carried out if onboard systems such as the rendezvous radar or computer should fail.

● **Studies continue**—The orbital altitudes quoted are not necessarily the final ones that will be selected for the first rendezvous mission. They are the figures used in the detailed comparison of the three competing methods. Optimum altitudes for concentric-orbit rendezvous will be defined in studies that are now under way. "Now that one method has been selected," said Kraft, "we can solidify ground computer programs to bring this about."

MSC studies on *Gemini* rendezvous have been carried out in cooperation with McDonnell Aircraft Corp., USAF Space Systems Division, Martin Company, Aerospace Corp. and TRW Space Technology Laboratories.

If the *Agena* is re-ignited in orbit, the launch window for the *Titan II/Gemini* extends over 4½ hours. Without this re-burn, and with yaw steering of the *Titan* booster, the possible launch period is cut down to 28 to 30 minutes. The orbits of the two vehicles must be coplanar to within ½ degree.

The initial *Agena* orbit will be achieved with a single burn of the *Agena* engine. No re-burn to achieve a perfectly circular orbit is planned.

If the *Agena* orbit is slightly elliptical, the aim will be to go for a *Gemini* "circular" orbit of the same ellipticity, with the same line of apsides.

● **Alternatives**—One other method of rendezvous considered was to inject the *Gemini* first into an elliptical orbit having an 87-mi. perigee and a 161-mi. apogee. With the *Agena* again in a 161-mi. circular orbit, there would exist a point of tangency between the two orbits. Aim would be to rendezvous when both vehicles were close to the point of tangency.

The phase between the two vehicles is initially set by the launch time; subsequently it would be adjusted so that rendezvous would occur at a suitable point.

The launch window for the tangential and concentric methods is the same.

The third method studied was that of rendezvous at first apogee. This is similar to the tangency method except that the target vehicle must reach the point of tangency at the same time as the *Gemini* climbs to its apogee for the first time. It is, in effect, a direct ascent to rendezvous.

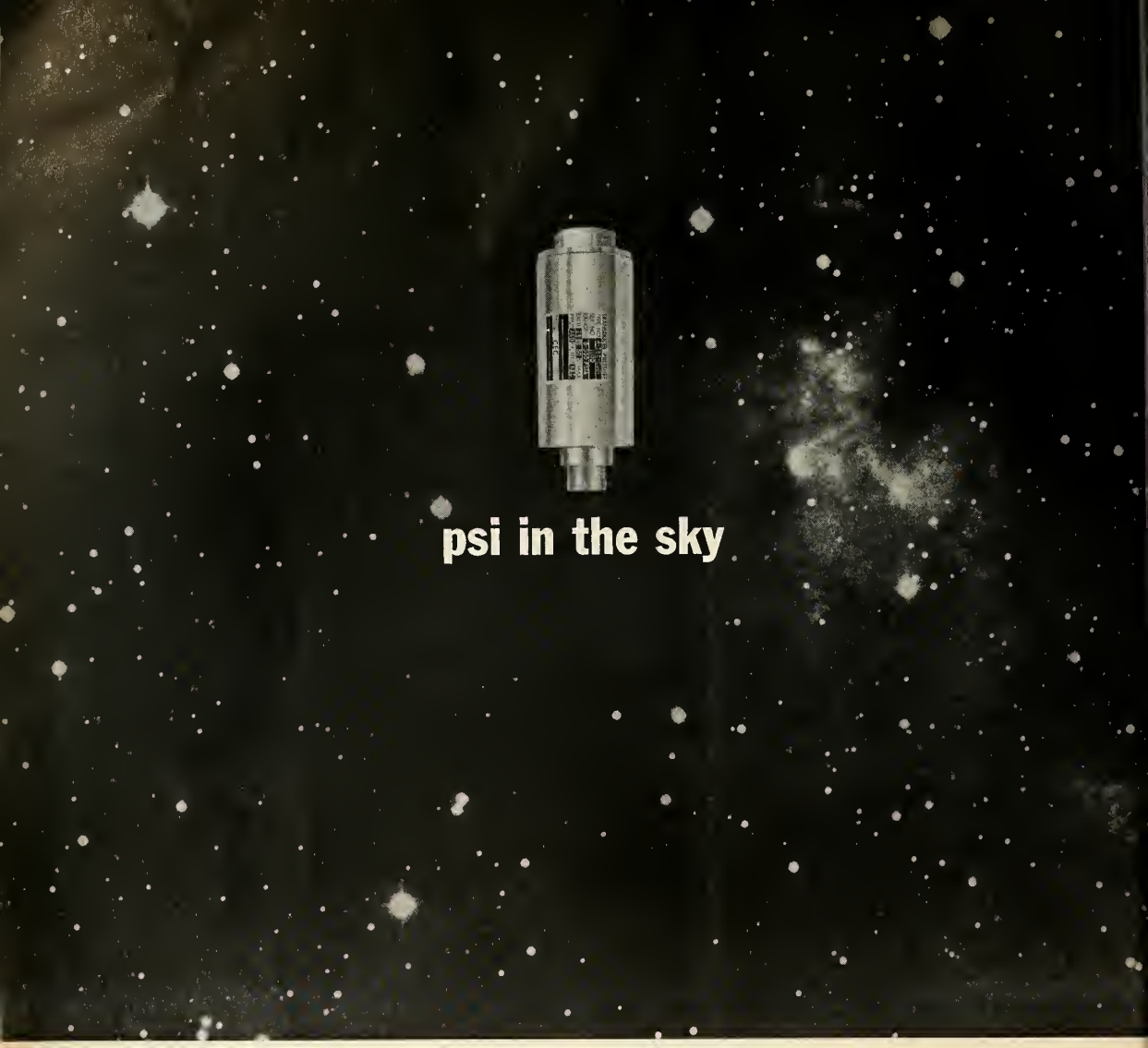
This last method is the most difficult from the standpoint of the effect of trajectory dispersions. The concentric orbit method is least sensitive to dispersions.

The direct ascent method is also the most critical from the standpoint of time of launch. If the launch goes off right on time, the fuel requirements are about the same as those of the other methods. But deviation from the correct schedule can incur extremely severe fuel penalties.

Direct ascent is also the most difficult method for the astronauts, since they have a lot of things to do in a very limited time. The approach has not been discarded, however, it will be studied further to see whether a suitable set of procedures can be devised, and it may be attempted later in the *Gemini* program.

● **Work cut out**—Study of procedures in orbital rendezvous will be a key task for the new NASA Manned Spaceflight Control Center here. Scheduled for operation in January, 1965, the Center will be capable not only of controlling rendezvous operations but also of simulating them.

Typical procedures to be studied during rendezvous simulation will be how to get commands to the *Agena* vehicle to ready it for rendezvous, what operational steps are best for the man looking at *Agena*, how the computers should process rendezvous data and transmit it to remote sites, and what means should be used to get information to astronauts. ■



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CEC's 4-390 is a chamber-type instrument that assures absolute and gage measurements of fluids and gasses in pressure ranges of 0-100 psi to 0-5000 psi.

Success of the 4-390 is due, of course, to its advanced design. For it is a high-output, unbonded strain gage transducer with integral, solid-state power supply and amplifier.

And just look at the 4-390's specifications!

- Excitation circuit isolation—100 megohms min. between output and primary power ground at 50 volts d-c.
- Linearity and hysteresis — ±0.5% max. of full range output, combined effects.
- Frequency response—flat within 0.1 db from d-c to 10,000 cps.
- Compensated temperature range — 30°F to 200°F.
- Repeatability — 0.1% of full range output.
- Altitude—0-60 psia ambient without effect.
- Shock—100 g half-sine-wave for 10 ±5 ms without damage.
- Weight—10 oz. max., excluding mating connector.

Obviously, CEC's 4-390 is made to order for maintaining superior performance characteristics in extreme acceleration, vibration and shock environments.

Equally important, the 4-390 is a *quantity* produced standard item. *Variations* are also available for specialized environments or unusual structural applications. And, CEC has the facilities and design capability to produce even more advanced instrumentation to meet the ever-changing demands of pressure measurement.

For complete information about the 4-390 High Output Pressure Transducer, call or write for Bulletin CEC 4390-X13.

CEC Transducer Division

CONSOLIDATED ELECTRODYNAMICS

A SUBSIDIARY OF **BELL & HOWELL**/PASADENA, CALIF. 91109
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND AND FRANKFURT/MAIN, GERMANY

Circle No. 7 on Subscriber Service Card

Technical Countdown

ELECTRONICS

Miniature Fuel Cell Shown

Allis-Chalmers' newest hydrogen-oxygen fuel cell weighs in at 14 lbs., 9 oz., and is capable of producing up to 50 watts electrical power. Shown for the first time publicly at last week's AIAA meeting in Washington, the system follows by one year development of a 35-lb., 50-watt predecessor also developed by the firm. Both were designed under Air Force contracts for orbital spacecraft auxiliary power. The step advance in weight reduction, according to company scientists, resulted from use of a simplified vapor control method of water elimination from the fuel cell. The approach obviated the need for normally required recirculation pumps, condensers, and water separators. The new cell reportedly will be flight-tested soon in an Air Force satellite.

Another Spectrum Gap Breached

Continuous-wave and pulsed laser operation employing argon, krypton, xenon, and neon, has been achieved by Hughes Aircraft Co. at more than 60 new wavelengths. The new lasers, reported Dr. William B. Bridges of Hughes Research Laboratories and E. I. Gordon and E. F. Labuda of Bell Telephone Laboratories in the May 15 issue of *Applied Physics Letters,* has produced peak pulse power of the order of 10 watts with maximum repetition rates of 2 kc. Covering a wide range of frequencies up to ultraviolet, the majority of the new color lines are in the blue-green portion of the spectrum, the paper said. In the CW mode, the lasers produced up to 160 mw output using a 10-in. tube.

Megawatt Pulses Obtained at 1 Cps

One-hundred-megowatt peak power output at pulse rates above one per second has been achieved with a ruby laser synchronously Q-switched by Raytheon's Laser Advanced Development Center. Ten-nanosecond pulse widths at this power level were produced, the company said. Using a Raytheon LH8 laser, Q-switching was performed with a Baird-Atomic JX-2B Electro-Optic Light Modulator. Outputs as high as 500 megawatts will be realized, said one company official, as the R&D program continues.

Pulsed Laser Hits 300 Watts

Peak power outputs of over 300 watts in a single spectral line at wavelengths of 1.117 microns have been achieved with a pulsed gas laser at the Martin Co.'s Orlando, Fla., research center. The laser obtained the 310-watt output with a pulse repetition frequency of 2,700 pps and a pulse duration of 0.7 microsecond. The device uses a 50:1 helium-neon mixture at a total pressure of 220 torr. Excitation is through a 3-Mw dc pulser with a pulse duration of 0.2 microsecond.

Now a Shortage of Physicists

The latest extraction from the last survey taken by the National Register of Scientific and Technical Personnel and other sources indicates a severe shortage of physicists by 1970. Current projections show a total of 59,300 jobs for physicists by that year with only 38,000 physicists available. In 1960 there were 29,000 jobs for physicists but only 17,300 physicists. These and a host of other "alarming" statistics have been published in the report, "Physics—A Statistical Handbook 1964," published by the American Institute of Physics. A physicist is defined as a person with a bachelor's degree in the field and two years experience. The solution, says the report: have the $10,000 to $15,000 per annum physicists go into $7,000 to $8,000 per annum teaching jobs. The weakest educational area is in the high schools.

MATERIALS

New Range of Quartz Fabrics Marketed

Quartz fabrics with some five times the strength of currently used leached glass fabrics are being commercially marketed by the Industrial Glass Fabrics Dept. of J. P. Stevens & Co. The Stevens market effort is being directed toward high-temperature areas in both liquid and solid engines. The fabrics are both woven and non-woven. Four quartz fabrics are available in tape form 0.25 in. to 1 ft. in width and in broad fabric form 38 in. wide. Among the special coupling agents used are those compatible with high temperature phenolics and epoxies, silicone resins and the polyimides.

New Form of Tantalum Produced

A special vacuum melting and processing technique perfected by engineers at National Research Corp., subsidiary of Norton Co., is being used to produce Stable Grain Size (SGS) tantalum. NRC spokesmen claim the SGS tantalum is the first to alleviate the problem of oxygen embrittlement associated with excessive grain growth at high temperatures. The new tantalum's re-crystallization temperature is about 2,000° C compared to about 1,200° C for the conventionally produced version. SGS also has about 300% greater high temperature strength at 1,650° C with a comparable improvement in oxygen tolerance. The product is available in alloy form and in all standard production tantalum shapes.

Volatile Flox Measurement Simplified

A procedure that accurately determines the amount of fluorine in flox in minutes has been developed by scientists at the Astronautics Division of General Dynamics Corp. The method uses a spectrograph and a special stainless steel test cell coated with Teflon to measure the amount of ultraviolet light absorbed by the fluorine present. The test can be used at launch and storage sites and during actual fueling operations to keep tabs on flox mixture deviations. The sample is vaporized and expanded into the test cell. The light absorption percentage is read directly from a spectrophotometer recorder and converted to weight or volume of fluorine through prepared tables.

Wyman-Gordon Test Forging New Alloys

Advanced work in the forging of alloys such as IMI679, Rene 62, Rene 64, Udimet 630 and experimental work in collaboration with other firms is in progress at Wyman-Gordon. The Worcester, Mass., forging company is also working with the high-strength titanium alloy T-13V-11Cr-3A1, with which both Curtiss-Wright and Pratt and Whitney have separately succeeded in passing the 1-million-in. yield strength/density goal in solid rocket motor cases. In addition, complex shapes in titanium are forged to tolerances that almost eliminate final machining. Development is beyond the lab stages with testing extending into forging and destructive tests of full size components.

Big Test Table for Saturn S-1C Tops Rigorous Boeing Specifications

Century-Detroit's 34-ft.-dia. tool operates in test with no deflection whatever; key is fully compensated bearing

by John F. Judge

DETROIT—A massive test table with almost incredible operating characteristics will soon be delivered to the Boeing Co.-operated Michoud *Saturn S-1C* assembly plant by its designer and builder, Century-Detroit Aerospace Division.

The 360,000-lb., 34-ft.-dia. instrumentation tool will be used in checking for accumulative tolerances on various portions of the *Saturn V* first stage.

The huge table was built to exacting tolerances and specifications—and exceeded these in some of the pre-delivery tests conducted at Century-Detroit. From the table's center to the 30-ft.-dia. line, the table meets a ±0.008 in. tolerance; the remaining 4-ft. section, ±0.002 in.

Center axis run-out of the table is less than 0.0005 in., and the specified table top plane of rotation of 0.5 arc sec. has been met.

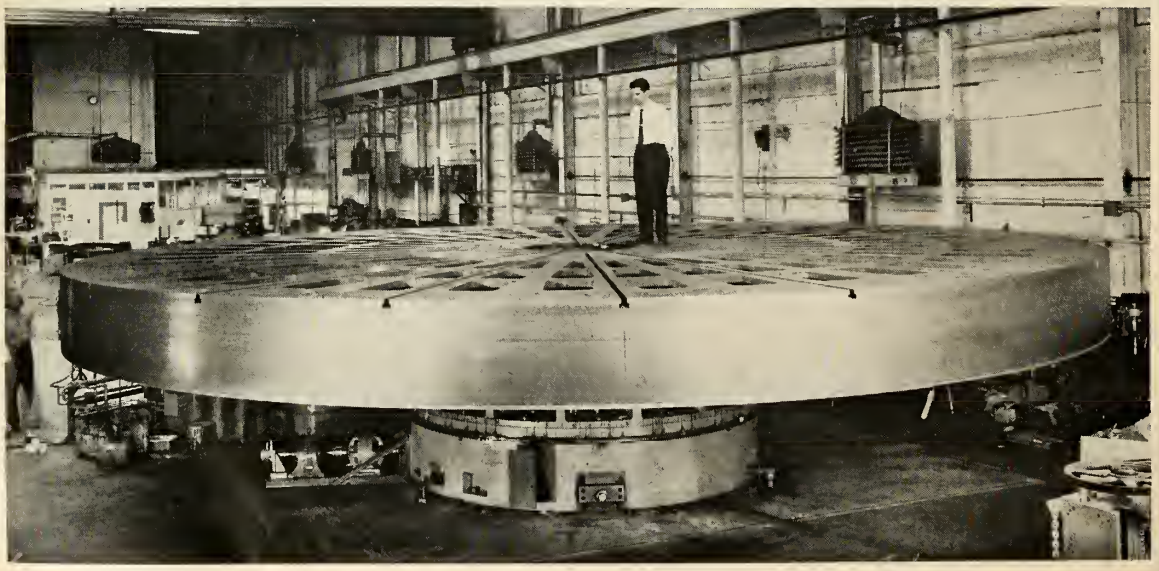
Total deflection with a full 80,000-lb. load is pegged at 0.001 in., and the differential deflection at any point under load was specified at 0.002 in. In the actual test, no deflection at all was found.

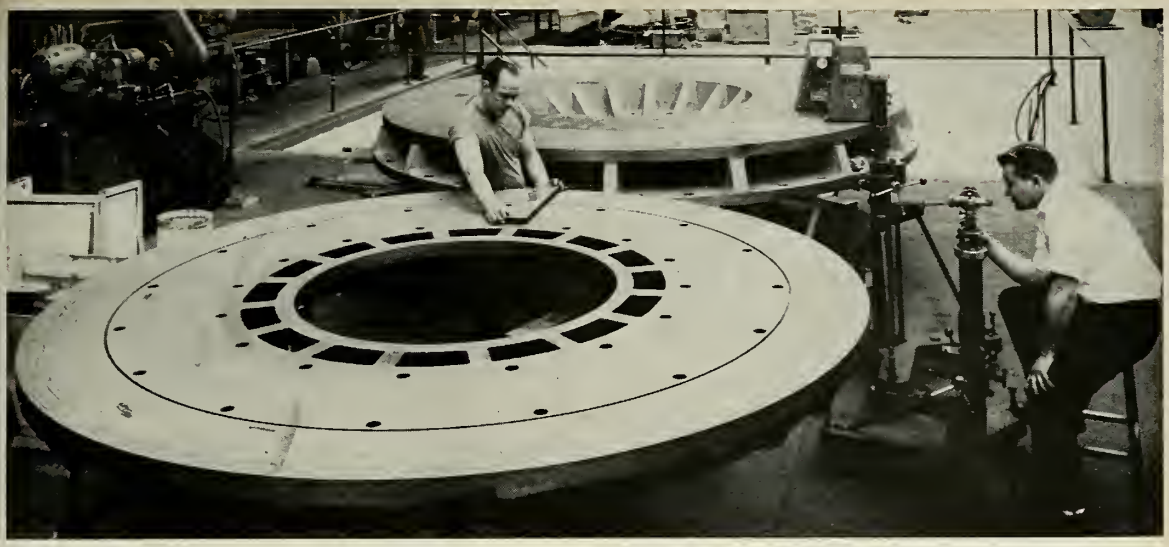
Angular position accuracy is within 2 seconds of arc on a repeatable basis. This permits the positioning of a reference point anywhere on the table through a small screw micrometer.

All of the controls are housed in a portable console, which allows the operator freedom to place the console anywhere around the periphery of the table when running an inspection.

● **Bearing design**—Key to the high performance of the table is the fully compensated pressurized bearing design used in its construction. Gordon H. Porath of Century-Detroit describes such bearings as using an external pressure source to provide static support. This means the lubricating film support is completely independent of the bear-

COMPLETE SATURN ROTARY TABLE Model CD-RT-408-PMPR just prior to its checking-out procedure at Century-Detroit. The test unit uses an Inductosyn angular readout.





FRONT DISC is the lower thrust face, and its mate, the upper thrust face, lies just beyond. Pie-shaped Meehanite segments are bolted to the upper thrust plate, forming the actual table top.

ing's rotational speed, Porath explains.

Fluid pressure support pads located radially in the journal stabilize the rotating member exactly in the center of the journal at any number of rpm's from extremely high speeds to zero revolutions.

Porath says such bearings are at least an order of magnitude in accuracy better than the best super precision ball or roller bearings made. In addition, the accuracies are permanent due to the low laminar oil flow and the complete elimination of metal-to-metal contact.

The symmetrical oil flow pattern and the very low velocity laminar flow free pressurized fluid bearings from the uncertainties of random torques.

There are 32 oil input pads on the bearing surfaces—16 on each journal and lower surface. Breakaway force at the 17-ft. radius was 1.25 lbs., but M. L. Greenberg, manager of the Aerospace Div. says the full diameter test will probably come out to less than 1 lb. This is a remarkably low starting friction for such a large table.

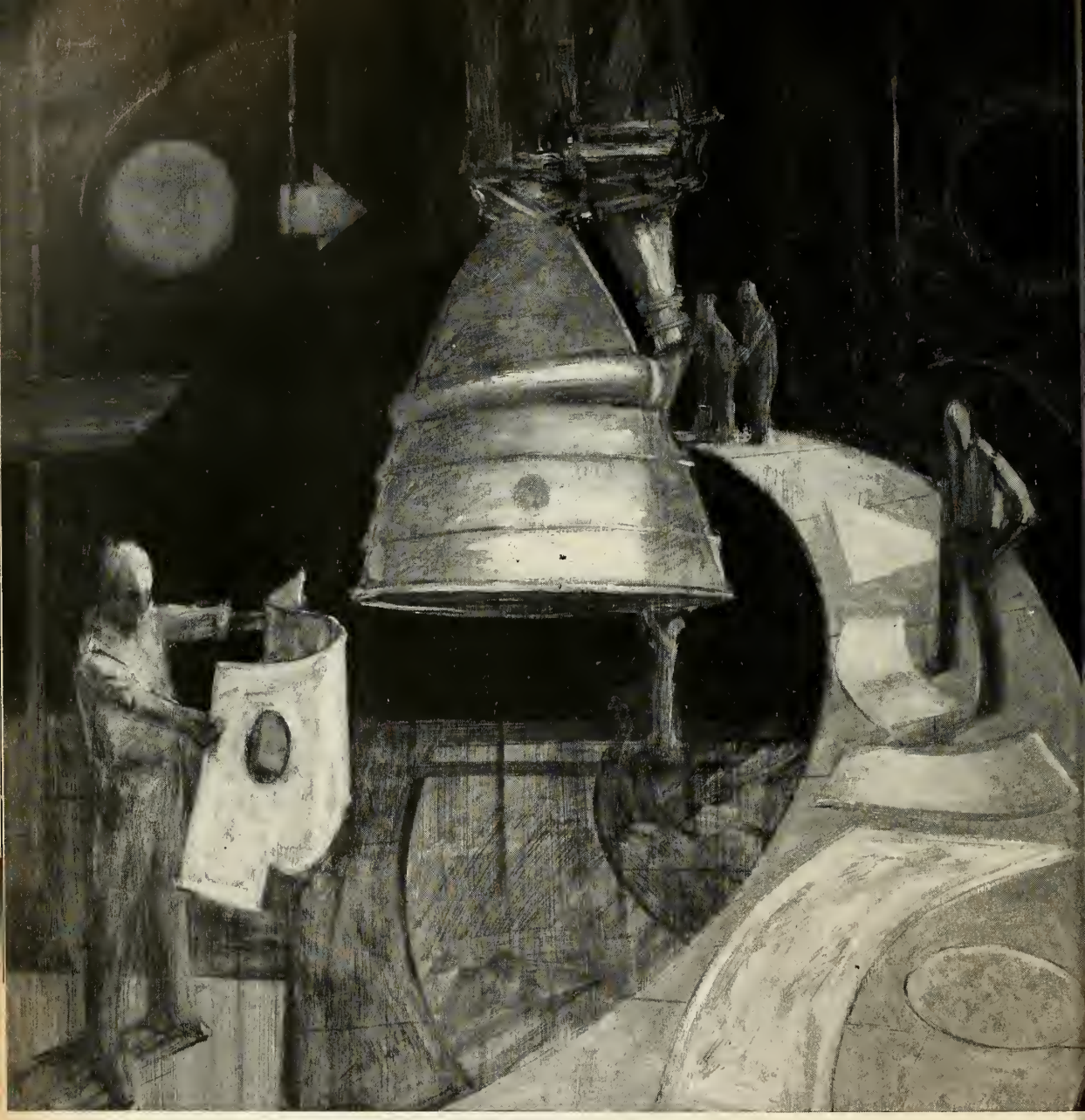
● **Uses**—Boeing will use the table to check out various subassemblies of the *Saturn* S-1C stage. These include the thrust structure assembly, inter-tank assembly, forward skirt assembly Y-ring and miscellaneous subassemblies too large for other inspection devices.

All of the tooling associated with these assemblies will also be handled on the table, as will the propellant tank bulkhead assemblies.

The table may be used as a machine tool back-up if necessary. Boeing has already established procedures for metal removal rates of 0.5 to 3 rpm. This is not the basic purpose of the table, but it could serve as such a machine tool fixture if *Saturn* production were affected by other tooling down time. ■

HEART OF THE $275,000 table is this doughnut bearing surface. Oil feed pads are visible around the periphery.





THE PRACTICAL MEN AND THE ROCKET ENGINE Today's giant rocket engines have existed for ages. But only in imagination, for tangible construction awaited a new breed: the practical engineers of aerospace.

These are men who never stop their search. Through thousandfold testing, their engines grow ever simpler, more reliable. And knowledge is born. How to improve components—or eliminate. How to group engines for compound power—then match that power with a single new engine. And then, at what would be the final step, they begin again. Testing. Simplifying. Perfecting. Then seeking beyond perfection.

In this constant quest, the men of NAA's Rocketdyne Division are playing a leading role. Their engines have launched most of America's satellites and space vehicles, and will power man's journey to the moon.

Throughout the aerospace industry, men like these—men of a practical bent—are constantly at work in every scientific field. Their mission: creating operational systems from purest theory.

These are the practical men—transmuters of ideas to reality in the Age of Space.

North American Aviation is at work in the fields of the future through these divisions: Science Center, Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

First Color Surveys Of Moon Now Expected in 1966

Bidder's conference this month to decide on improved retro-rocket system for Surveyor; early flights detailed

LOS ANGELES, CALIF.—Shots of the *Surveyor* soft-landing lunar spacecraft in 1965 will carry a television camera, but quantitative visual inspection—photogrammetric and color surveys—will not be carried out until 1966.

In the breakdown of the spacecraft's payload, a fixed-lens downward-looking camera is counted as part of the engineering instrumentation and not as the scientific payload.

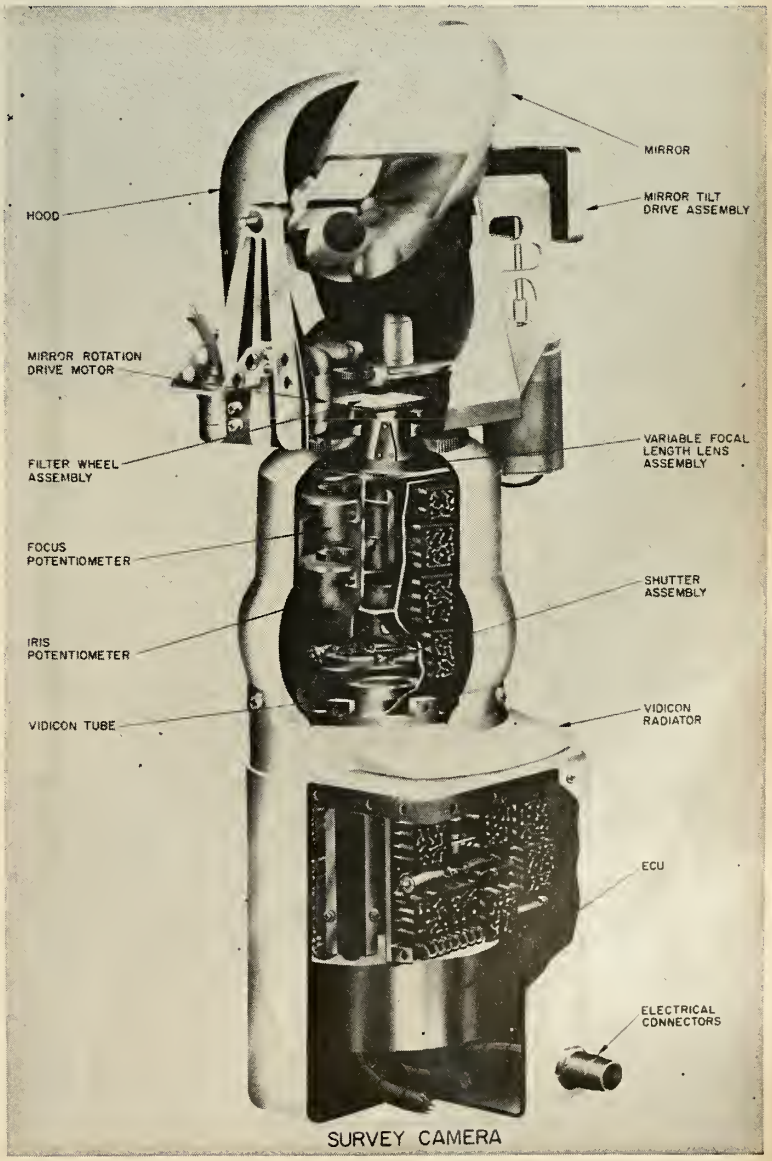
In 1966 flights, a high-quality television system, taking panoramic, close-up, color (by filter wheel) and stereoscopic pictures will be carried. This is a 600-line system, with equal resolution in the horizontal direction, providing 8 to 10 gray shades. Pictures are taken through a 0.15-sec. shutter and transmitted once every 3.5 sec.

At 1,000 miles above the Moon the thrust axis of *Surveyor's* retro-rocket will be aligned along the velocity vector, and the fixed-lens camera turned on. Pictures will be transmitted prior to main retro-engine ignition at 60 to 50 mi. altitude.

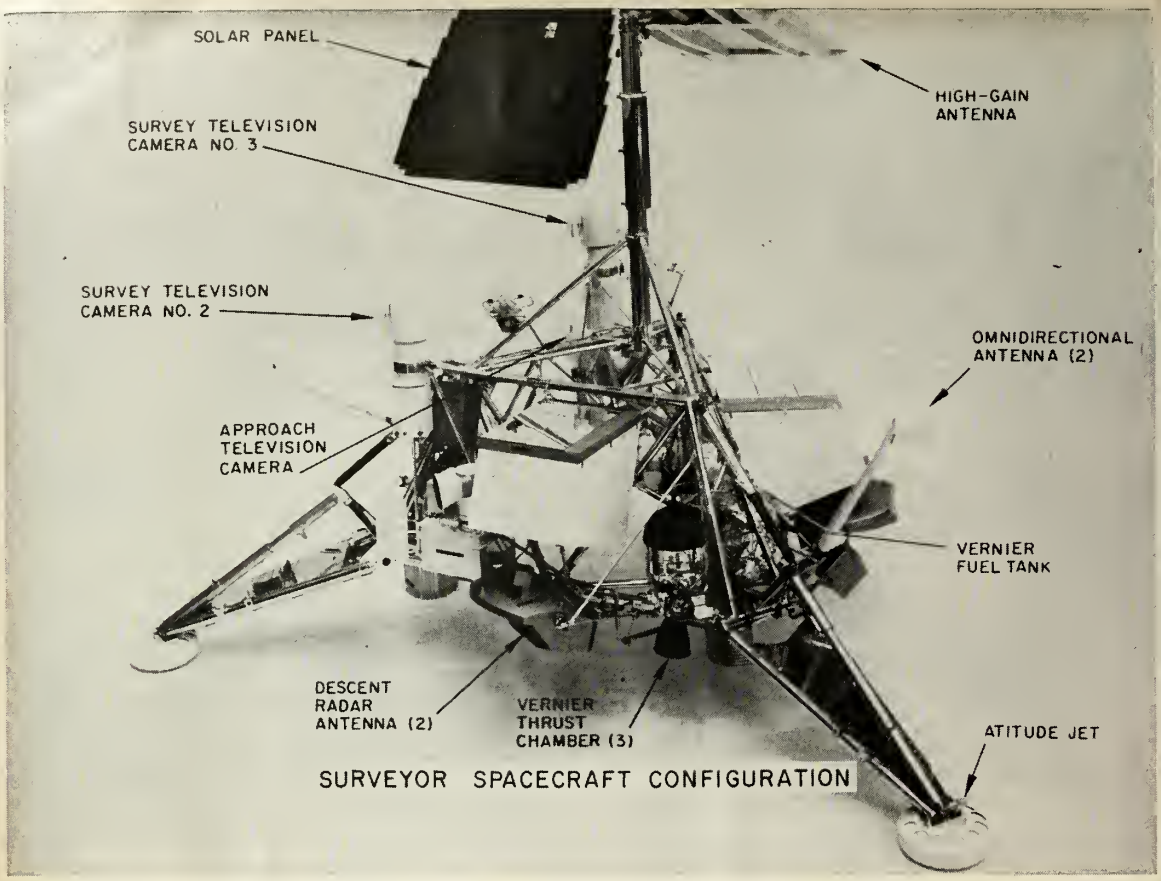
No decision has been reached on the subsequent television coverage during descent, but quite possibly the camera will be left on during retro-rocket staging and vernier descent, the last pictures being obtained between 20,000 and 10,000 ft.

Initial *Surveyor* shots will suffer the disadvantage that the parking-orbit technique developed for accurate injection into a lunar trajectory cannot be used. This is because *Centaur* will not have the re-start capability possessed by *Agena-D*. Direct ascent will give a wider trajectory dispersion and will call for a large velocity correction by the mid-course motor, some 15 hours after launch.

The increased fuel-weight penalty incurred and overweight problems with the RADVS system (Radar Altimeter and Doppler Velocity Sensor) had led JPL to seek improved performance in



SURVEY CAMERA



SURVEYOR SPACECRAFT CONFIGURATION

the retro-rocket provided for soft lunar landing. A bidder's conference for an improved retro-rocket is expected in July.

● **Touchdown**—The actual descent velocity expected after retro-rocket burnout and ejection is 400 ± 125 fps. at 28,000 ft. This is then reduced to 13 ± 4.5 fps at lunar touchdown, by a vernier rocket system. Actual shut-off of vernier engines is planned to occur at an altitude of 13 ft. and a velocity of 5 fps. The premature shut off is to avoid stirring up too much dust, if there is any.

First flights will approach along a trajectory normal to the lunar surface. Later flights will follow an angular course.

Describing progress on stability drop tests on simulated lunar surfaces, Dr. Leo Stoolman, *Surveyor* program manager, said that stability had been proven at greater slopes. Even at 30-degree slopes the spacecraft proved to be stable within the velocity range expected. "But," he added, "if we land on a slope of 60° we've got problems." Stoolman was speaking at an AIAA dinner meeting here.

● **In case it isn't cheese**—He said it was also possible that the lunar surface was of such low density that the spacecraft might keep going straight on in. But instrumentation on the spacecraft would still give useful information.

The three legs of *Surveyor* have been fitted with strain gauges and accelerometers. Readings from these are telemetered through the omni-directional low gain antenna, with a bandwidth of 7 cps per channel. The high-gain directional antenna will not be correctly oriented at impact.

When *Surveyor* does land, a survival assessment will be carried out using data from the omni-directional antenna. Preliminary assessment of the lunar surface will be made. Earth-acquisition by the high-gain planar-array antenna and solar panel alignment towards the Sun will follow. Solar panel alignment repeats every 12 hours.

● **TV from the Moon**—In the 1966 shots, television camera operation in a narrow-angle mapping mode will follow, producing about 1,000 pictures in an hour. Then seismometer and meteorite ejecta experiments will operate for about 15 hours. After this, narrow-angle mapping will start up again and continue for about eight hours, with surface sampler operation taking place at the same time. When operated as a pick, the surface sampler transmits over wide-band telemetry, alternately with television frames.

These experiments will be repeated until about touchdown plus 100 hours, when a color television survey and an alpha-ray scattering experiment will be carried out. The color survey involves taking successive pictures of the same scene through different-colored filters —carried in a wheel that rotates in front of the camera—with reconstitution of the colored scene on the ground. The alpha-ray experiment includes six collimated alpha sources, two alpha detectors and four proton detectors.

Panning of the television camera in azimuth and elevation is carried out by a mirror. The picture is put into focus by means of a zoom lens.

The power system of *Surveyor* is designed to provide a fully-charged battery by the time the day-night terminator reaches the spacecraft. Then the *Surveyor* systems go into a hold condition with the major part of the stored electrical power being used to maintain an even temperature within the spacecraft. Insulation for the two thermal compartments is provided by walls containing 75 sheets of aluminized Mylar. ■

Home-Made Oscar III Comsat Awaits Piggy-Back Agena Ride

by Robert Lindsey

SUNNYVALE, CALIF.—*Oscar III*, a translater communications satellite capable of relaying 25 conversations on a 50-kc bandwidth, is being readied for launch after July 15.

Negotiations now under way with the Defense Department indicate the "home-made" satellite will be orbited piggy-back by an Air Force *Agena* from Vandenberg AFB, as were the first two *Oscar* satellites. The nation's first non-governmental satellites, they were launched Dec. 12, 1961 and June 1, 1962, and broadcast the word "Hi" in Morse Code to radio hams around the world.

Radio-amateur members of Project Oscar Inc. report they have solved design problems in the payload which delayed launching of the vehicle for about two years.

Three payloads are now in final flight qualification tests—one for launching and two for back-up.

Meanwhile, the Oscar Assn. has established a new command and control center. Previous posts were in members' homes or borrowed offices—at Foothill College in nearby Los Altos Hills.

● **Satellite details**—Weighing 25 lbs., *Oscar III* will be a 2-meter translater satellite. It will receive a 50-kc band centered at 144.10 mc and re-transmit this band centered on 145.9 mc with a peak output of 1 watt. A 25-milliwatt beacon transmitter on 145.85 mc will broadcast the "Hi" message again. Additionally, the transmitter will have a channel to telemeter temperature data from the satellite to Earth.

The system will be powered by an outdated but usable battery originally intended for an Air Force space program, which was donated by a major aerospace firm. A few solar cells will be mounted on the package to augment the battery, but they will not be used to recharge the battery.

Oscar III's life expectancy, determined by the power supply, is three weeks, or approximately 336 orbits. It will have separate 19-in. monopole whip antennas for beacon, receiver and transmitter. (Reflecting the innovations of the home-made system, the antennas are common, re-plated steel measuring tape).

Oscar III was intended to weigh 15 lbs. instead of 25, but power requirements dictated more battery weight than hoped for in early designs. The battery takes up more than half the system's weight. In another compromise, expected lifetime was cut from four weeks to three.

In shape, the satellite will be similar to *Oscars I* and *II*, although slightly larger, at 12x17x6½ in. It is made of case aluminum and magnesium and insulated with epoxy foam. In the qualification trials, it is being tested for these environmental conditions: temperature, −35°C to +65°C; shock, +50 g's; acceleration: +50 g's; altitude, more than 200,000 ft.



SOLAR CELLS and steel measuring tape monopole antennas can be seen on Oscar III.

● **Oscar's electronics**—Electronics in the payload are essentially all solid state and represent original designs of the radio hams, most of whom are employed by aerospace and electronics industries on the San Francisco Peninsula. The system uses a 72.5-mc transistor oscillator, crystal-controlled transistor amplifier and diode frequency multiplier (145 mc).

Keyer circuitry includes a transistorized timing generator, five "scale-of-two" transistorized dividers and a diode matrix pulse selector. Telemetry circuitry uses a timing generator that is temperature sensitive and keying rate is a function of the satellite's internal heat. Ground observers will determine temperature by counting the time in seconds it takes for the satellites to send 10 "Hi" messages.

After their much-acclaimed success with *Oscars I* and *II*, the radio amateurs planned to launch an active communication satellite in the spring of 1962. But the problems of designing a system within the severe weight and space restrictions delayed the project. They are now convinced their design is a good one, and take credit for a major state-of-the-art accomplishment in circuit design and the fact they have developed a communication satellite with minimum expenditure (about $1,000 in donated parts).

● **A breakthrough**—One of the major triumphs of the program was development of a linear amplifier that required development of a transistor unavailable on the commercial market. It now may have a market of its own, according to Oscar Assn. officials.

Recent qualification tests indicate the linear amplifier has an output of 1 watt, with intermodulation distortion products better than −27 db below peak output.

Developers of *Oscar III* stress it is a translater, not a repeater, satellite. Two-meter repeater systems have been used to accept a single signal, demodulate it and re-transmit the signal on another frequency.

But the *Oscar III* package does not need to demodulate the signals. It will repeat a segment of the VHF radio spectrum, permitting simultaneous use of the repeater capability by a number of stations of mixed types. Transmitters using AM, FM, single sideband and CW, all will have access to the system.

Since the orbit of *Oscar III* depends on the vehicle it hitches a ride aboard, operations can be predicted fully. However, the orbit is expected to be more than 200 mi. high. Range of the system is a function of altitude, but it is expected to permit two-way conversations between 25 pairs of hams at ranges of 1,000 miles. Most should be able to converse for 10-15 minutes.

Oscar Assn. officials are now making final plans for the traffic on the satellite; they emphasize it will be open to radio hams in all nations, including those behind the Iron Curtain. More than 3,000 tracking reports were filed with *Oscar I* and *II;* Officials here predict the number will increase by a factor of 10 with the new vehicle. ■

BIG SHOT!

Lockheed Propulsion Company has successfully test-fired a massiv 156-inch diameter solid rocket motor in a feasibility demonstratio for the USAF Space Systems Division. This first firing of the world' largest solid propellant motor produced almost 1,000,000 pound thrust. This fall, a second test firing will develop a thrust of 1,250,00 pounds. Still larger motor firings are planned. Basic objectives of this first test program were to static fire the large soli rocket motor with an ablative-throat nozzle; and to demonstrate the feasibility of a jet tab system of thrust vecto control. Innovations included jet tabs in a large engine and use of 18% nickel maraging steel plate for the motor case The success of the LPC test is a tribute to those who have long held that large solid propellant boosters are feasible

PROPULSION ENGINEERS & TECHNICIANS: Programs such as this further strengthen Lockheed Propulsion's position in th ever-growing propulsion industry. LPC is a fast-growing company in a position to provide outstanding openings fo men of real talent and training. We invite you to write: Professional Employment Manager, Dept. 5208, P.O. Box 111, Redlands, California. An equal opportunity employer.

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Mergers and Acquisitions

Litton Industries, Inc., Beverly Hills, Calif., is negotiating for acquisition of all assets of Universal Controls, New York City. Under a proposed plan, Universal shareholders would receive approximately $5.50 per share at the closing date and 50¢ per share within one year thereafter in cash and Litton's Series A convertible preferred stock. . . . *Teledyne, Inc., Hawthorne, Calif., and Servomechanisms, Inc., El Segundo, Calif., are planning to merge. A proposed plan will offer 1 share of Teledyne common stock for each 10 shares of Servomechanisms.* . . . Colt Industries, Inc., New York City, has agreed to acquire H.&H. Wilson, Inc., Bell, Calif., manufacturer of milling equipment for the missile/space industry. Colt will offer one share of its stock for three shares of Wilson. . . . *Mount Clemens Industries, Inc., Bala Cynwyd, Pa., has purchased Consolidated Missile Co., Inc., Torrance, Calif. Consolidated Missile manufactures components for the missile/space industry and has developed techniques for fabricating and machining exotic, hard metals.*

Company Facilities

Itek Corp., Lexington, Mass., has opened its Data Analysis Center in Alexandria, Va. The division will provide photographic analysis and evaluation services to the government and industry. . . . *Union Carbide Corp.'s Linde Div. has completed installation of a 7,400-ft., 6-in.-dia. cryogenic pipeline at Edwards AFB, Calif., to supply liquid oxygen to three F-1 engine test stands. Installation is part of NASA's Thrust Test Facility at Edwards.* . . . Loral Electronics Corp. has moved its corporate headquarters from New York City to Scarsdale, N.Y. . . . *Inca Engineering Corp. will merge both its Pasadena, Calif., facilities into a new 8,500-sq.-ft. building in San Gabriel, Calif. Inca performs engineering and prototype fabrication work on special test sleds, force multiplying systems, thrust stands, calibrators, high capacity pivot flexures and vacuum chamber/diffuser systems.* . . . North American Aviation, Inc., Downey, Calif., is constructing a 150-ft.-dia. rotational research device with the capability of conducting 30-day tests simulating orbital space station conditions with four men. The $310,000 company funded facility is being built by the Rucker Co. of Oakland, Calif., and is expected to be in operation by mid-November. . . . *Chemical and Aerospace Products, Inc., has moved to a new 14,000-sq.-ft. facility in Wilmington, Calif. The firm, which produces precision weldable electronic circuitry, circuit modules and interconnection systems, was formerly located in Gardena, Calif.*

New Activities

Integrated Circuit Engineering Corp. has been formed in Phoenix, Ariz., to provide microcircuit engineering services to electronic equipment and systems manufacturers. Glen R. Madland is president of the firm. . . . *Amphenol-Borg's FXR Div. is consolidating its microwave test equipment and component product lines by expanding its facilities in Danbury, Conn., and closing its Woodside, N.Y., plant. The move is expected to be completed by the end of 1964.* . . . Elsco Systems, Seattle producers of solid-state circuitry, voltage limit detectors and instruments in the klystron gas measurement field, has changed its name to Pacific Electro Dynamics, Inc. The company plans to expand its product line in the near future to include operational amplifiers, voltage comparitors, power controlling devices and other related products. . . . *Molectro Corp., Santa Clara, Calif., is now selling a microelectronic photomask service to other semiconductor manufacturers, research laboratories and companies with in-house microcircuit lines.* . . . Applied Science Associates, Inc., Dallas, has established an office in Houston. The firm markets electronic and engineering products. . . . *Guide Manufacturing Co., manufacturer of microwave and electronic components and subsystems for the missile/space field, is constructing a 16,000-sq.-ft. facility in the Guide Industrial Park, Sun Valley, Calif. Occupancy is scheduled for August.* . . . Benrus Watch Co., Inc., New York City, has purchased a 47½-acre building site in Ridgefield, N.J. A $3-million facility will be constructed there later this year.

International

Sangamo Electric Co., Springfield, Ill., has appointed Instronics, Ltd., Stittsville, Ont., as Electronic Systems Representative for Canada. . . . *Krauss-Maffei A.G., a manufacturer of heavy equipment for the plastics and chemical industries, has opened a new research laboratory in the Allach suburb of Munich, Germany. Principle assignment of the laboratory will be to find solutions for current problems facing plastics and plastic processing machinery. A specific area of activity will be in exploring the possibilities of injection molding of intricately designed products and components in the weight range of 200 to 500 oz.*

EIA Admits 17 Firms

Seventeen companies have been admitted to the Electronic Industries Association during the past year. The firms are: Auerbach, Pollak & Richardson; Charles Bruning Co.; The Bunker-Ramo Corp.; Cambridge Scientific Industries, Inc.; A. B. Dick Co.; Eastman Kodak Co.; Electron Products Div. of Marshall Industries; Fusite Corp.; William W. Garstang; Hogan Faximile Corp; Kalb, Voorhis & Co.; Memorex Corp.; Round Hill Associates; Muirhead Instruments, Inc.; Phelps Dodge Electronic Products Corp.; Standard Electronics Corp.; and Waterman Instrument Corp.

Structures Designers:

DO YOU KNOW THE ELASTIC MODULUS OF THORIUM DIOXIDE?

This and thousands of other essential data are contained in REFRACTORY CERAMICS FOR AEROSPACE, a *materials selection handbook* prepared by Battelle Memorial Institute under contract to the U.S. Air Force. Easy-to-consult charts and tables comprise 90% of this comprehensive 440-page book. Also included is a 70-page supplement, bringing in latest available data through 1962. This handbook provides mechanical, thermal, and physical properties of the following ceramics for selection and specification in anticipated aerospace and other high-temperature applications:

Borides	Sulfides
Carbides	Aluminides (Intermetallic)
Nitrides	Beryllides (Intermetallic)
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contracts

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$112,353,000—**Pan American World Airways,** New York City, for continued management of test-support facilities in the Eastern Test Range.

$3,205,000—**Lockheed Aircraft Corp., Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for further research into a satellite control network.

$3,203,786—**The General Tire & Rubber Co., Aerojet-General Corp.,** Sacramento, Calif., for production of *Titan II* propulsion systems.

$2,700,000—**United Aircraft Corp., Hamilton Standard Div.,** Windsor Locks, Conn., to develop equipment for checking out electrical systems on the solid propellant rockets of the USAF *Titan III-C* launch booster.

$2,500,000—**The Magnavox Co.,** New York City, for production of ARC/90 communications equipment.

$1,800,000—**General Telephone & Electronics Corp., Sylvania Electric Products, Inc.,** New York City, for development, fabrication and delivery of advanced electronic receiving equipment for incorporation into an overall airborne system.

$1,250,000—**North American Aviation, Inc.,** Anaheim, Calif., for ground-support equipment for the *Minuteman* guidance and control system.

$561,787—**Vitro Corp. of America, Vitro Laboratories Div.,** New York, for the design, fabrication and testing of new timing systems for the Eastern Test Range.

$473,000—**United Aircraft Corp., Norden Div.,** Norwalk, Conn., for the continuation of work on new techniques for the automated design and manufacture of semiconductor integral circuits.

$267,000—**Collins Radio Co.,** Dallas, for transistorized distance measuring equipment.

$203,451—**Motorola, Inc., Military Electronics Div.,** Scottsdale, Ariz., for extension of a microwave system from Edwards AFB to Point Arguello, Calif.

$128,152—**Bell Aerospace Corp., Bell Aerosystems Co.,** Buffalo, N.Y., for propellant orientation and venting systems for zero-gravity applications.

ARMY

$15,156,341—**Hughes Aircraft Co.,** Fullerton, Calif., for missile equipment, fire-distribution systems and classified electronics equipment.

$9,571,285—**Day & Zimmerman, Inc.,** Philadelphia, for loading and packing boosters, primers, and detonators.

$7,500,000—**General Telephone & Electronics Corp., Sylvania Electric Products, Inc.,** Needham, Mass., for additional classified electronics equipment.

$5,500,000—**Universal Match Corp., Unidynamics/St. Louis,** St. Louis, for production of *Pershing* missile erector-launchers and related spare parts.

$5,500,000—**Bendix Corp.,** Baltimore, to make classified electronic equipment.

$2,972,902—**Raytheon Co.,** Lexington, Mass., for further design and development of *Hawk* missiles, and for technical services and materials for the installation of *Hawk* modification kits.

$2,456,776—**Martin Marietta Corp.,** Orlando, Fla., for further engineering work on the *Pershing* missile.

$2,400,000—**Cubic Corp.,** San Diego, Calif., for a long-range survey system study.

$1,800,000—**Hesse Eastern, Inc.,** Everett, Mass., for rocket launchers.

$1,700,000—**International Business Machines Corp.,** Washington, D.C., for classified electronic equipment.

$1,656,188—**Ingraham Co.,** Bristol, Conn., for metal parts of boosters.

$1,506,928—**Hayes International Corp.,** Birmingham, Ala., for *Pershing* missile trainers.

$1,369,362—**AT&T, Western Electric Co.,** New York, for installing modification kits in the *Nike-Hercules* missile system.

$1,220,639—**Raytheon Co.,** Bedford, Mass., for further research work on an Army anti-missile project.

NAVY

$23,500,000—**Maxson Electronics Corp.,** Great River, N.Y., multiple year contract for production of *Bullpup* air-to-surface missiles.

$9,834,244—**Collins Radio Co.,** Dallas, to provide electronic equipment for military aircraft.

$8,014,632—**Thiokol Chemical Corp., Reaction Motors Div.,** Denville, N.J., to make liquid propellants and rocket engines for the *Bullpup* missile.

$7,749,252—**General Electric Co.,** Schenectady, N.Y., to manufacture guidance system components for the *Polaris* missile.

$5,699,255—**Honeywell, Inc.,** Minneapolis, for *Polaris* guidance-system assemblies.

$2,500,000—**Planning Research Corp.,** Westwood, Calif., to continue R&D relating to the automation of information handling in command operations control (OPCON) centers.

$2,164,846—**Honeywell Regulator Co.,** West Covina, Calif., for antisubmarine warfare trainers.

$1,889,469—**Sperry Rand Corp.,** Great Neck, N.Y., for radar sets for the missile range at Point Mugu, Calif.

$1,855,792—**Ling-Temco-Vought, Inc.,** Dallas, for operating instrumentation facilities at the Navy's Pacific Missile Range Station, Honolulu.

$1,476,828—**Electromagnetic Industries, Inc.,** Sayville, N.Y., for bomb and missile cradles for air-launched weapons.

$1,065,390—**Chromecraft Corp.,** St. Louis, for *Mighty Mouse* rocket launchers..

$1,000,000—**Northrop Corp., Nortronics Div.,** Anaheim, Calif., for automatic test equipment for missile checkout aboard *Polaris* submarines.

NASA

$1,800,000—**Aeronca Manufacturing Co.,** Middletown, Ohio, for a large deep space Cassegrain tracking antenna system.

$1,559,000—**Lockheed Aircraft Corp., Lockheed Missiles and Space Div.,** Sunnyvale, Calif., for *Mariner* C mission.

$839,282—**Hayes International Corp.,** Birmingham, Ala., for engineering and fabrication services for *Saturn* launching and GSE.

$733,000—**Federal Electric Corp.,** Paramus, N.J. to provide instrumentation support services to the John F. Kennedy Space Center.

$700,000—**Hayes International Corp.,** Birmingham, Ala., to design and build a system to provide "clean" nitrogen gas for the *Saturn IB* guidance gyro bearings.

$621,150—**Santa Barbara Research Center,** Goleta, Calif., for a dual radiometer assembly for project Scanner.

INDUSTRY

$5,300,000—**Gen. Telephone & Electronics, Sylvania Electric Products, Inc.,** New York, from **General Cable Corp.,** Bonham, Tex., for approximately 1,000 miles of hardened cable to be used in an underground communications system for the *Minuteman* intercontinental ballistic missile.

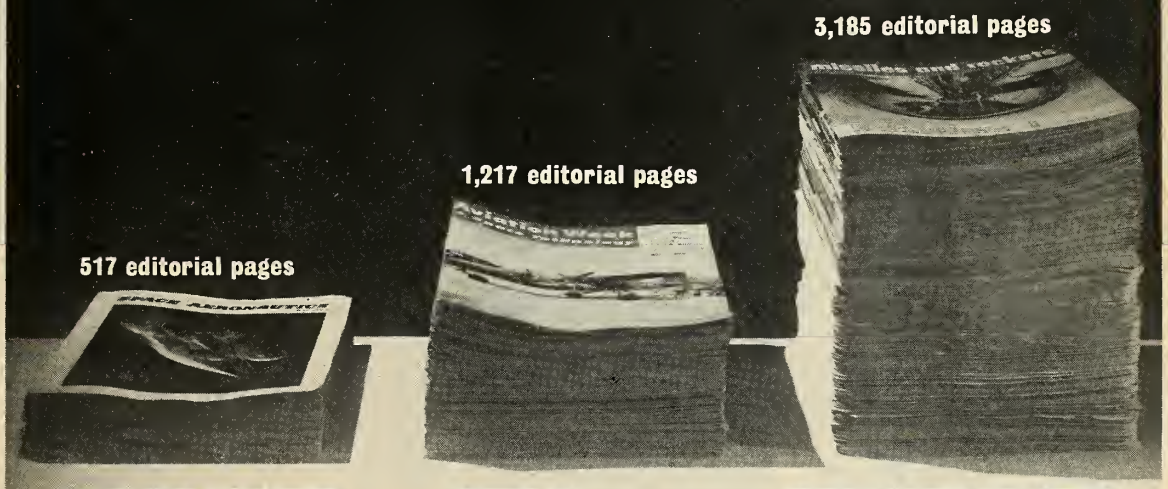
$3,000,000—**General Dynamics, Convair Div.,** San Diego, Calif. from **Pan American World Airways' Guided Missile Range Div.,** for continuing work on integration of advanced telemetry equipment at Merritt Island, Fla.

ARMS CONTROL AND DISARMAMENT AGENCY

$31,824—**Kirsbner Associates,** Albuquerque, N.M., for a study to evaluate the need for and effectiveness of selected public and private policies, programs, and types of administrative machinery which could be used for dealing with regional economic adjustments to assumed changes in national defense expenditures.

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Canopus Star Sensor Will Provide Method To Correct Surveyor Course

Instrument developed by Santa Barbara Research Center; reliability goal is 0.97 at 80% confidence for 66 hours

SANTA BARBARA, CALIF.—The *Surveyor* star sensor that will help provide a plane of reference for course correction 60,000 miles along the unmanned spacecraft's cislunar trajectory will identify and lock onto one selected star by measuring its brightness relative to the Sun.

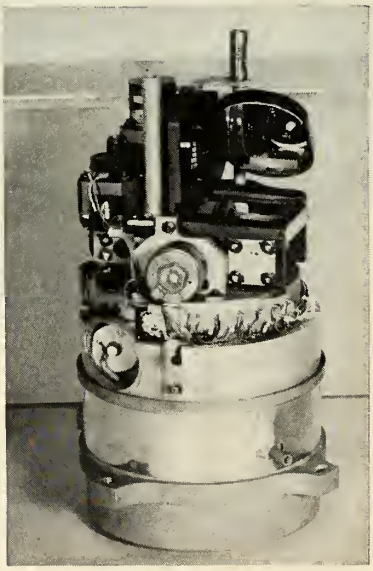
Canopus, the star selected, is the second brightest star in the sky. It is not only ideally located as a navigational reference but also differs by nearly one magnitude from the brightest and the third brightest stars.

Geometry of the navigation maneuver rules out interference by planets inside the Earth's orbit. All other planets except Mars and Jupiter are always too dim to interfere. From calculations, Mars and Jupiter will be too bright to be mistaken for Canopus at the discrimination levels built into the star sensor system.

The system accepts star signals between ⅔ and 1½ times as bright as Canopus. It does not respond to extended sources such as the Earth or Moon.

The mid-flight course correction calls for a plane of reference established by two known lines of direction from the spacecraft. One of these is gained by sensing the sun. The second is provided by Canopus, which gives a defining line nearly at right angles to the Sun line.

● **Sun sensors assist**—Sun sensors in *Surveyor* will generate pitch and yaw signals that enable the roll axis of the spacecraft to be pointed at the Sun. A search for Canopus will then be made by rolling the spacecraft about this axis.



SENSOR'S acquisition mirror (top) can be pre-adjusted to suit any launch date. Vertical rod in top left foreground houses Sun telescope. Photomultiplier is above cylindrical compartments housing circuits in base.

The Canopus sensor has three functions. It gives a signal indicating Canopus is in its field of view. It provides an input to the attitude control system proportional to the roll angle of the star. And it gives a signal proportional to the total starlight collected.

The telemetered output of this last signal can be used to find Canopus if the primary attitude control system fails.

● **Evolution**—Santa Barbara Research Center, a subsidiary of Hughes Aircraft Company, developed the Canopus sensor under contract from Hughes and JPL. Eleven flight models and two prototypes have been produced. Now the reliability demonstration phase is underway. Aim is for a reliability of 0.97 at the 80% confidence level for the 66-hour mission.

Canopus is barely visible in the Northern Hemisphere, so calibration of the sensor has been carried out by reference to Sirius and the Southern Californian Sun. Relative brightness of Sirius and Canopus has been measured from the NASA Minitrack station in Santiago, Chile.

Expressed in magnitudes, the relative brightness of Canopus and Sirius were measured as +0.91. The discrimination thresholds in the sensor are set at ±0.45.

Discussing future developments of the sensor, Dr. Robert Tolley, SBRC manager, said that additional orders for *Surveyor* might be expected, but a different sensor was likely on the *Lunar Orbiter*. The 60-day mission made an

image dissector a more attractive proposition than the photomultiplier used in the *Surveyor* system. Also a different mission geometry was involved.

● **Working details**—The entire Canopus sensor weighs 4.9 lbs. and is sealed in an atmosphere of dry nitrogen.

Starlight enters through a glass window, is reflected from an adjustable acquisition mirror and travels via a scan mirror to an objective lens. The light then passes through a rotating chopper disc onto the photocathode of an 1P-21 photomultiplier.

Field of view of the sensor is 4° in the roll direction and 5° in the acquisition direction (parallel to Sun line).

In addition, a pre-flight adjustment of the acquisition mirror enables the whole field to be moved ±15° in the acquisition direction to take account of the launch date. Describing the system, A. H. Sochel, project engineer, SBRC, said that the field of view of the sensor is sufficient to acquire Canopus at a launch date up to 48 days from the time of setting the acquisition angle.

The scanning mirror covers ±2° roll angle. Accuracy of angular readout is of the order of 0.1°.

Sunlight enters a miniature Sun telescope through an attenuating filter. Variation of angle of incidence is accommodated by use of an opal glass diffuser. Relay lenses and a color-correction filter cause sunlight to emerge from a pinhole at the base of the telescope with the same color and intensity as the light from Canopus.

The same chopper disc interrupts the modified sunlight, which is collected by a filter-optics light pipe to be focused on the photocathode, at the same point as the star image.

● **Signal separation**—Because the two light signals are chopped at different frequencies (starlight at 3.9 kc, sunlight at 2.3 kc), the electrical signals they produce in the tube can be separated by filters. The Sun signal is fed to an automatic gain-control amplifier that controls the high voltage on the photomultiplier, and hence its gain. This loop holds the Sun signal at 5.4 volts, peak-to-peak.

The star channel output is then directly proportional to the ratio of the star and Sun intensities.

Three separate circuits process the star channel signal.

Motion of the scan mirror modulates the star signal. A shaped cam makes the motion linear through most of the field. Mirror reversal occupies 4.4 milliseconds—less than 10% of the 50 millisecond scanning period.

A modulation phase-detector compares the modulation envelope of the star signal with a reference square wave and gives a dc output proportional to the position of the star along the roll axis.

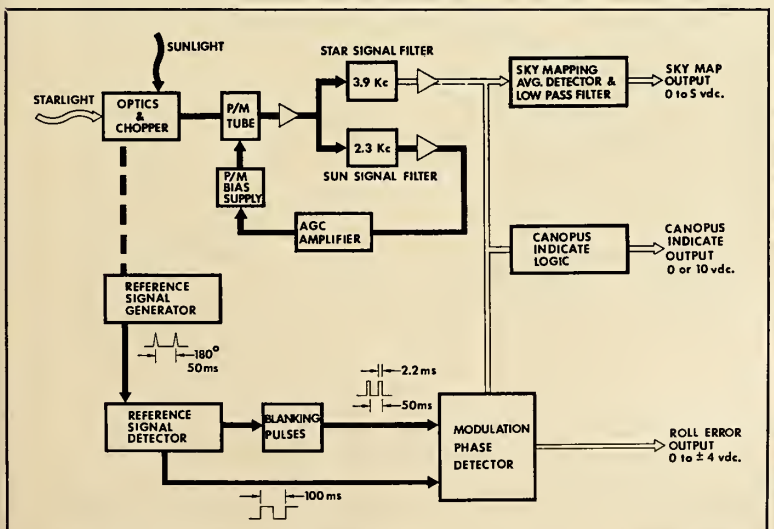
As the star goes from right to left of center, the voltage goes from positive to negative, being zero when the star is at center.

During reversals of the scanning mirror, the phase-detected signal is blanked by pulses generated from the reference signal pulses.

A Canopus-indicate circuit gives a 10-volt signal when the star signal amplitude falls between two preset voltages.

A sky-mapping circuit containing an average detector and low-pass filter gives an output that varies with the total starlight collected. This signal is telemetered to Earth as a backup, enabling a ground-commanded search to be made for Canopus, if necessary. ■

SUN SIGNAL holds gain of photomultiplier constant so that output of star signal filter represents ratio of star brightness to Sun brightness.



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Design Cure Advocated For Radio Frequency Interference Problems

LOS ANGELES—Radio frequency interference on Air Force launch pads has been causing severe loss of time and money, mainly through failure to tackle RFI problems in the design stage. Other contributing causes are lack of suitable instrumentation and failure to stick to specifications.

Delays varying from days to months at the current $35,000 daily operating cost of a launch facility have taken place.

Even the Vandenberg closed-loop RF checkout system installed to enable simultaneous countdown of two vehicles (M/R, Oct. 28, p. 42) has suffered from RF interference—the very problem it was designed to avoid.

These and similar problems were brought forward by Lt. Col. W. E. Birks, Space Systems Div., USAF Systems Command at the recent Sixth National Symposium on Electromagnetic Compatibility (formerly RFI), sponsored here by the Institute of Electrical and Electronics Engineers.

Requirements for interference reduction put forward by both NASA and Air Force speakers indicate a growing market for spectrum-signature equipment and for instruments that will record transient effects in the increasing volume of digital systems going into space vehicles. Initial efforts to develop equipment of this type were described by a number of speakers.

● **One example**—Birks said that it took five weeks and seven design changes to remove RF interference from one top-priority AF payload sitting on the launch pad.

"The only light thought that results from such a fiasco," he said, "is that people were educated about the problems in this way of doing things." He was referring to use of trial and error methods instead of designing from the start to avoid RFI.

A good engineering design in the first place could not have approached the cost of the trial and error method, said Birks.

Similar remarks were made by several speakers. The theme of the symposium was, in fact, the application of "down-to-earth" analysis and design to space-age systems problems.

Birks gave the following history of a series of delays caused by interference from one particular type of telemetry transmitter in satellite payloads.

● **Case histories**—In October, 1962, a spurious signal from the transmitter interfered with telemetry from the payload's booster. After one day's delay, the situation was resolved by launching the missile and losing the booster data.

Shortly afterward a similar transmitter in a different payload interfered with a ground receiving station. After a day's delay the launch was conducted with the ground receiving station shut down.

In December, 1962, the same telemetry transmitter caused interference with civil and military ground-controlled approach (GCA) equipment in the area. This caused several days' delay while the transmitter was replaced.

About 15 days later the same transmitter again caused interference with a booster.

In February, 1963, the transmitter caused interference within a space system on another pad. This caused several hours delay on the first pad before the decision was made to shut down the second pad, delaying its launch schedule.

Last April, the transmitter again interfered with local GCA equipment. In this case the transmitter was shut down and the pre-launch checkout was waived. This could have led to loss of all data from a launch costing several million dollars.

The interference between adjacent pads when telemetry systems were tested "on the air" led to the installation of a closed-loop cable system at Vandenberg. Experience has shown, however, that radio-frequency leakage from the system has caused interference with sensitive receivers, said Birks. The initial design specifications followed IRIG requirements (200 microvolts per meter at 100 ft.) and were quite inadequate.

● **New specs needed**—Birks said that SSD feels RFI specs should be overhauled to meet current space needs, but that this did not mean stretching the state of the art beyond what it is. "A little updating should cure it," he said.

Birks concluded "I am not pessimistic at all about the outlook for RF compatibility in the space age. I think we have reached the point where we will move toward better EM compatibility." He did, however, emphasize the urgency of this requirement.

Criticism of previous conferences on RFI was made by Capt. Robert Fields, Wright-Patterson AFB, Ohio. Having read through proceedings of past conferences, he said, "It seems that people always talk about the same thing: fire-fighting rather than solving problems at the design stage. You read one set of proceedings and you've read them all."

He said that Rome Air Development Center is thinking of having all RF spectrum signatures of equipment taken by the contractors building the equipment. This would be instituted during the new fiscal year. He foresaw a number of problems when contractors started carrying out their own measurements, because different techniques led to different answers.

● **Against new specs**—Sam Skolnik, also of Wright-Patterson, said that one of the biggest problems in RFI is lack of uniform enforcement of previous specifications. "We would be better off if we enforced many of the older specs rather than thinking up new ones," he said.

Pointing out that milliwatts within a vehicle cause the same malfunction as would require megawatts from outside the vehicle, he said that provided there was adequate frequency control, the Air Force's main problem was caused by lack of intra-compatibility within the vehicle.

This problem was made more difficult by the fact that unnecessary weight in interference suppression cannot be tolerated. "We are fighting quite desperately to save ounces" said Skolnik.

Discussing the increased use of digital circuits in space vehicles and their susceptibility to transient interfer-

ence, Skolnik said that present instrumentation and technique leave a lot to be desired. This was a serious situation because a single transient can, and has, caused the loss of a complete vehicle, he said.

Agreeing with the statement that many space digital systems are highly vulnerable to transients, George Goldfarb of Aerospace Corp., said that test plans submitted by contractors were sometimes inadequate in this respect because they would overlook the need to collect data on transient effects.

● **Transient monitoring studied**—A practical approach to a broadband multi-channel transient monitoring system was described by J. W. Ashforth, Stoddart Aircraft Radio Company Inc. He pointed out that knowledge of when transient interference occurred and how many circuits were affected was needed, but this information could not be obtained with a tuned receiver. A broadband system was required to give amplitude-time characteristics of the intereference. And this type of measurement had to be made on many circuits simultaneously.

Stoddart is studying a system of 36 identical instrumentation channels. Each channel consists of a step attenuator, video amplifier, recorder isolation amplifier, and detector. Frequency response is flat to within ±3 db from 30 cps to 15 mc. The channels take signals with peak amplitudes between 0.1 and 100 volts from an RF probe, and deliver the outputs to a recording or display device.

Discussing the future of EMC instrumentation, R. W. Sproul, Metrics Division, Singer Company, said even the best equipment consumes too much time and manpower, and was too highly dependent on operator skill. A great increase in degree of automation and in operating speed was required, he said.

For collecting spectrum signatures of operating radars, Electro-Mechanics Co. has instrumented a 200-ft. pneumatically-operated portable plastics tower. The electronics are designed to be usable in other types of vehicles as well.

Describing the programmed electronic system, developed for the Navy's Bureau of Ships, G. F. Roberts and F. J. Morris said that all RF circuitry was located at the top of the tower. Transmission characteristics measured by the equipment included power output, spurious emissions, emission spectra, and modulation characteristics. ■

SPACE ELECTRONICS

Hardened Telemetry System Overcomes Circuit Design Obstacles

Los Angeles—An FM/FM telemetry system for small high-performance rockets has operated through a neutron blast of 10^{14} nvt. Peak gamma rate during exposure was 10^{12} R per sec., for an integrated dose of 10^5 R.

These are the radiation levels that might be expected 200 yards away from a 1-kiloton nuclear explosion.

Sandia Corp., which directed development of the system, is now working on a unit that will function through considerably higher radiation levels.

Standard IRIG subcarrier oscillators, a two-watt, 260 mc. transmitter, an in-flight calibrator, and a magnetic tape recorder make up the present system. It is intended for 9-in.-dia. rockets, and meets shock requirements of 125 g for 3 milliseconds, 80 g steady state acceleration, and a spin rate of 10 rps. Temperature limits are 0-70° C.

● **Design hurdle**—Circuit design, rather than component selection, was the main problem encountered.

The all solid-state system uses 28v power and has 10% higher consumption than standard, non-hardened systems. Size and weight are the same as those of standard systems. Costs are about doubled.

Describing their development program at the National Telemetering Conference, V. K. Smith and D. L. Trapp said that circuit design was, in general, made easier because certain commercially available diodes, resistors, capacitors, temperature-compensation devices and other circuit components had proved to be adequate for radiation environments. Also, many data were available at Sandia on transistor radiation characteristics.

Vector Department, Norden Division of United Aircraft, developed the SCOs and transmitters. Avionics Instrumentation division, Astro Science Corp. developed the tape recorder. Tests on the units were carried out at Sandia's Pulsed Reactor Facility and Engineering Reactor Facility.

Radiation specification for the SCO was that the center frequency should change by less than 5% of the bandwidth from 0 to 10^{14} nvt (neutrons per sq. cm.) Output voltage was to change by not more than 10%.

The three-step calibrate voltage of the in-flight calibrator has less than ± 0.5% error under radiation conditions, and reduces data error to less than ± 1% from the input of the SCOs through the output of the transmitter.

● **Hardening the circuits**—Among the steps taken in development of the SCOs were careful selection of zener diodes, replacement of conventional resistors with thin-film metal or carbon types, use of dura mica capacitors throughout, and use of high-speed (gc.) switching transistors.

No varactor diodes suitable for the specified radiation environment were discovered for use in the transmitter, and a pre-irradiated germanium transister was used instead. The base-emitter junction served as the varactor.

From their experience, Smith and Trapp suggest the following guidelines for design of hardened circuits:

—Circuits must be designed to operate over extreme variations in transistor H_{fe}.

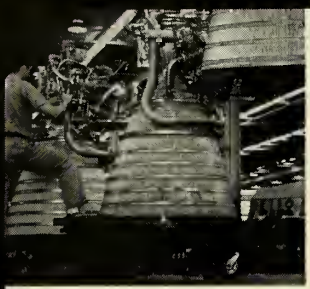
—The highest-frequency transistors available must be used.

—Radiation-hardened circuits are difficult to qualify at low temperatures. Circuits that operate above 0°C simplify the problem.

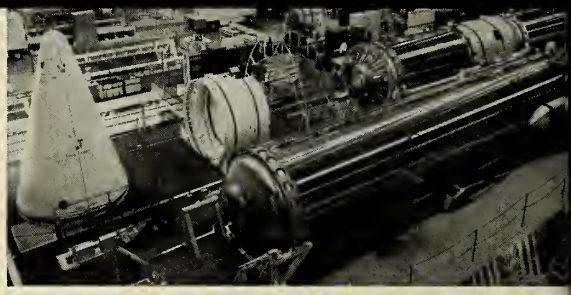
—Transient response, particularly when associated with high-level gamma inputs, must be optimized by low-impedance circuits and minimum use of charged capacitors.

—Reactor tests should be used to prove and select all components. ■

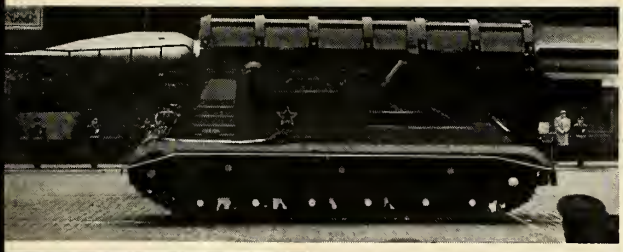
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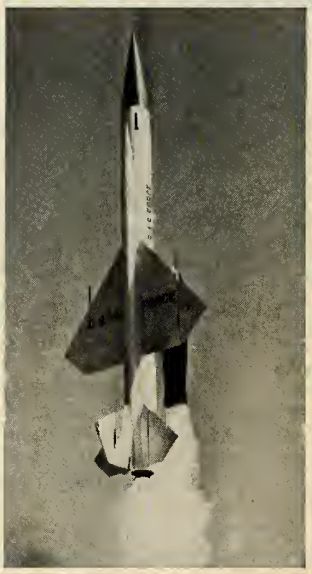
























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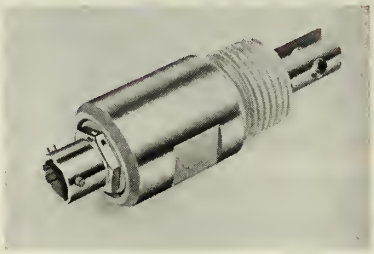
New Product of the Week:

Separation Thruster

Space Ordnance Systems, Inc., has developed an ordnance-actuated thruster mechanism that separates on command while carrying full tension or compression loads.

Designated the SO5 series, the device is applicable for ejection of instrument packages and structure pods, parachute release and clamp separations.

A pressure cartridge is installed in the thruster and fired on command, thus forcing an auxiliary piston inside the thruster to move. This movement allows a collet to contract, thus releasing and ejecting the main thruster piston causing ejection of the package. The



device is available in a range of materials for specific requirements of strength, weight, temperature and nonmagnetic applications.

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Antenna Signal Source

Sanders Associates, Inc.'s Microwave Products Dept. has announced two antenna signal sources featuring output freqeuncy drift of less than $\pm 0.0015\%$ over a temperature range of $-7°$ to 70°C.

The Models DG-502 and DG-503 operate with maximum output power capabilities from 0.1 to 10 mw. Dual band models offer up to 12 fixed frequencies within two bands—400 to 450 mc and 1,200 to 1,320 mc.

Circle No. 152 on Subscriber Service Card

Retort Furnace

A retort furnace for metallurgical research on the effect of controlled heating and quenching has been introduced by Marshall Products Co.

The Model 176-00 is designed to perform under conditions of vacuum, nitrogen, hydrogen or inert atmospheres. It operates on 460v, 60 cps, with a maximum input of 15 kw. The heating element can produce and hold a maximum retort temperature of 1,100°C. The retort can be evaculated to 1×10^{-5} torr when clean and outgassed at 20°C.

Circle No. 153 on Subscriber Service Card

Transistorized Scaler

A transistorized scaler with a maximum counting rate of 200,000 counts per second has been introduced by Atomic Laboratories, Inc.

The unit is said to be ⅓ the size and ¼ the weight of vacuum tube scalers and exceeds resolution time of comparable scalers by a factor of 50. The device has a 6-decade readout visible up to 50 ft. away. Resolving time is 5 microsecs. Maximum repetition rate is more than 200 kc. Eight preset counting ranges—100; 400; 1,000; 4,000; 10,000; 40,000; 100,000 and 400,000—are controllable by a knob on the front panel.

Circle No. 154 on Subscriber Service Card

Temperature Control

A 28v dc transistorized temperature control system for aerospace applications has been developed by Electro-Mechanical Products Div., Barber-Colman Co.

The system consists of a transistorized control box, two sensing elements and a valve-actuator assembly. A pulse modulation technique helps increase transistor life and system reliability. Ambient temperature range is 0 to 125°F.

Circle No. 155 on Subscriber Service Card

FM Record Amplifier

An FM record amplifier designed for use with magnetic tape recorders is being marketed by Kinelogic Corp.

The Model EFR-1 is available in two linearity models, $\pm 0.25\%$ and $\pm 0.1\%$, and operates from a $\pm 10\%$ 28v dc supply. The unit features gradual overloading and thus does not cause sharp conversion discontinuities until a deviation of approximately 50% is reached. Other features include an input impedance of 100 K ohms and temperature range of $-20°$ to 85°C. It meets MIL-E-5272 specifications.

Circle No. 156 on Subscriber Service Card

Multiplex Channel Filter

A 10-channel miniaturized multiplex filter with an integrated video detector for each channel and elimination of spurious responses up to 10,000 mc is being marketed by American Electronic Laboratories, Inc. The device uses a single 500- to 1,000-mc input and has a channelized output every 50 mc.

Circle No. 157 on Subscriber Service Card

Television Camera

The 3100 series television camera for closed-circuit TV systems is available from Cohu Electronics, Inc.'s Kin Tel Div.

The unit features quick-change plug-in circuit boards accessible through a magnetic latch door on the rear of the chassis. It includes synchronizing generator options with scanning patterns of 525 or 729 lines with 10-mc bandwidth or 873 or 945 lines with 20-mc bandwidth. The camera may be equipped with remotely controlled accessories including 4:1 and 10:1 zoom lenses and 4-lens turret and camera controls. Operational voltage is 28v or 220v.

Circle No. 158 on Subscriber Service Card

Integrated Circuit

Amelco Semiconductor is marketing a differential amplifier monolithic integrated circuit with a common mode rejection of 100 db.

The Type D-13001 has a temperature stability exceeding 3μv per degree C. Drift time is less than 5 μv per day.

Circle No. 159 on Subscriber Service Card

Pulse Train Generator

A programmable pulse train generator, providing pulse trains of 1 to 999 pulses, has been introduced by Tempo Instrument, Inc.

The Model 91645 offers variable pulse widths and separations from 1 ms



to 99.999 seconds, independently preset in 1-ms increments. Timing accuracy is $\pm 1.5\% + 1$ ms for each preset time. Power requirement is 22 to 30v dc.

Circle No. 160 on Subscriber Service Card

Temperature Controller

Leesona Corp.'s Laboratories Div. is marketing a multipoint temperature controller-indicator, the Model 5162-4.

The desired temperature can be preset at the controller, which continuously scans the temperature at each process or system point and turns the power circuit off or on. The unit can be supplied with from 4 to 12 or more channels.

Temperature information is transmitted by a thermocouple. Input resistance ranges from 2,000 to 6,000 ohms, permitting a source impedance of over 100 ohms without degrading operational accuracy. Power output is from 0 to 2.5 kw at 110v per channel. Power delivery duty cycle is variable from 0 to 100%.

Circle No. 161 on Subscriber Service Card

Dual Output Magaverter

The Dual Output Magaverter, a static, solid-state analog voltage to frequency converter, has been introduced by Pioneer Magnetics, Inc.

The unit is linear to better than 0.1% with a temperature stability of better than 0.005% per degree C with ambients ranging from −40° to 55°C. Nine standard models provide full scale output frequencies of 30 cps to 100 kc. Input voltage range is 0 to 0.1, 0 to 1, 0 to 10, 0 to 100 and 0 to 1,000v.

Circle No. 162 on Subscriber Service Card

Tantalum Capacitor

A solid tantalum capacitor with a 10:1 size reduction over paper feedthrough capacitors with equivalent specifications has been developed by Cornell-Dubilier Electronics Div., Federal Pacific Electric Co.

The STF model is a 3-terminal device with line current carried directly through the terminal studs. The unit meets MIL-C-26655 requirements and has attenuation from 14 kc to 1 gc. Voltage ratings are 6 to 35v dc.

Circle No. 163 on Subscriber Service Card

Flame Photometer

Borders Electronics Co., Inc., has available an Electroselenium Limited flame photometer for estimation of alkali metals.

The device measures sodium, potassium, lithium or calcium content within ±1%. Two cu. cm. of sample are required.

Circle No. 164 on Subscriber Service Card

Pressure Switch

A dual differential pressure switch rated at 5 amperes resistive load with 2 amperes inductive load at 30v dc is available from Assembly Engineers, Inc.

The Model 3102-100 is a miniaturized switch capable of pressure ranges from 0-1.0 to 0-10.0 in. mercury and is guaranteed to MIL-E-5272 specifications. Operating temperature range is −65 to 165°F.

Circle No. 165 on Subscriber Service Card

Amplifier

A solid-state power amplifier for the range from dc to 1 mc has been introduced by Hewlett-Packard Co.

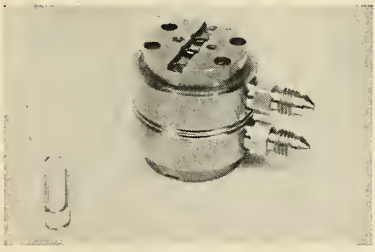
The Model 467A has a distortion of less than 0.01% and protection against accidental input voltages up to 200v peak-to-peak. Input impedance is 50,000 ohms for dc and greater than 40,000 ohms for ac, shunted by less than 100 pf. Gain may be varied from 1 to 10 in fixed steps accurate to 0.1%. Output impedance is less than 5 milliohms.

Circle No. 166 on Subscriber Service Card

Pressure Transducers

A series of ultra-low pressure transducers with full scale ranges as low as 0 to 0.01 psi is being marketed by Consolidated Controls Corp.

The 41PD17 transducers provide dc



output voltage continuously varying from 0 to 5v in response to pressure changes over the rated range. The detector element is of the variable reluctance type, employing a diaphragm as the single moving part. Input is 28v dc.

Circle No. 167 on Subscriber Service Card

Oscillator

Sonex, Inc., is marketing a constant-bandwidth voltage controlled oscillator, designed for aircraft and missile use and featuring an isolated input.

The Model TEX-3007CB can be used with different polarity transducer output voltages without readjustment. The device covers all proposed FM constant bandwidth frequencies from Channel 1C through 22C and 2CW through 22CW. Deviation is ±2 dc and ±4 kc. Temperature stability is within ±1.5% dbw over a range from −20° to 85°C.

Circle No. 168 on Subscriber Service Card

Tuning Fork Resonators

Philamon Laboratories, Inc., has available four new series of miniature and micro-miniature precision tuning fork resonators, designed to generate audio frequencies of 400 to 18,000 cps. Available accuracies range from ±0.05% to ±0.005% over military temperature ranges without the use of ovens. Accuracies of ±0.001% are also available.

Circle No. 169 on Subscriber Service Card

Solar Aspect System

Adcole Corp. is marketing a solar aspect system for use on non-spinning rockets and satellites.

The system consists of a Model 233C shift register and Model 133E sensors. Field of view is 128 x 128 degrees. Resolution is one degree and accuracy at transition is ±½ degree. Sensor measurements are stored in the shift register as a Gray-coded word and are serially shifted out to telemetry.

Circle No. 170 on Subscriber Service Card

Ferrite Circulator

A T-configuration ferrite circulator operating in the 215- to 260-mc range has been developed by Melabs for airborne and spaceborne applications.

The HO-7 is available with requested center frequency. Passband is equivalent to 2% of the center frequency; isolation is 20 db minimum; insertion loss is 0.7 db maximum. VSWR is less than 1.25.

Circle No. 171 on Subscriber Service Card

Miniature Resistor

Angstrohm Precision, Inc., is marketing the Type S-62 miniature resistor, rated at ⅛ watt at 100°C and derating to zero at 175°C.

The unit measures 0.098 in. maximum diameter and 0.38 in. maximum length and meets NASA 200-3 specifications. Resistance ranges available are from 50 ohms to 1 megohm at tolerances of ±1%, 0.5%, 0.25% and 0.1%.

Circle No. 172 on Subscriber Service Card

DC Power Amplifier

A 40-watt, transistorized dc power amplifier, the Model 732, is being marketed by Inland Motor Corp., subsidiary of Kollmorgen Corp.

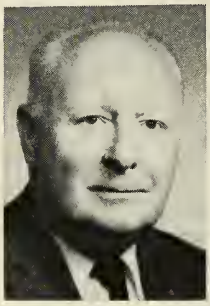
The unit has a power gain rating of 100,000 at maximum output and a current gain of 10,000 with a 10-ohm load at 1 amp. It weighs 2.2 oz. and measures 1¼ in. along any side.

Circle No. 173 on Subscriber Service Card

names in the news



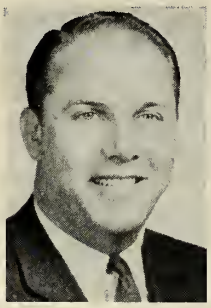
DUMAS



GEOGHEGAN



GOOD



COMMINS



EBERT

Arthur V. Holmlund: Elected president and chief executive officer of United ElectroDynamics, Inc., Pasadena, Calif.

Major General Alvin R. Luedecke, USAF (Ret.): Named Deputy Director of the Jet Propulsion Laboratory, Pasadena, Calif., beginning August 1. He was formerly General Manager of the Atomic Energy Commission.

Edward J. Dumas: Appointed research physicist in the Electron-Physics Dept. of the Princeton Div. of Electro-Mechanical Research, Inc., Sarasota, Fla.

Colonel William S. Collinson, USAF: Named Acting Test Director of the Defense Contract Administration Services Region, Philadelphia.

George Friedl, Jr.: Appointed Deputy Associate Administrator for Industry Affairs at NASA Headquarters.

John D. Hoffman: Named Chief of the Polymers div., U.S. Department of Commerce. He will direct polymer research and standards work at the Bureau of Standards.

Shirleigh Silverman: Appointed Associate Director of Resources Planning at the Bureau of Standards, U.S. Department of Commerce. He was formerly Research Director for the Office of Naval Research.

Bernard D. Haber: Elected vice president of North American Aviation, Inc., Downey, Calif. He was previously assistant to the president for research and engineering at NAA.

Eamonn D. A. Geoghegan: Named general manager at Dearborn Electronic Laboratories, Orlando, Fla. He was formerly vice president of engineering.

Harold M. Hart: Promoted to assistant general manager of the Equipment Div. of Raytheon Co., Lexington, Mass., and also elected vice president at Raytheon. **Robert G. Hennemuth:** Elected vice president of Raytheon.

Carl David Good: Joined Rocket Research Corp., Seattle, as senior research chemist. He was previously with Aerojet-General Corp.

Isabelle F. French: Elected president of the Society of Women Engineers. She is an associate member of the technical staff of the Bell Telephone Laboratories.

Dorman D. Israel: Appointed chairman of the Joint Technical Advisory Committee. He is vice chairman of the board of Emerson Radio & Phonograph Corp.

William Fogarty: Elected president of the Steam Heating Equipment Manufacturers Assn. He is manager of Illinois Products, Temper-Air Group, American Air Filter Co., Inc., Louisville, Ky.

Charles L. Kent: Elected president of the American Society for Testing and Materials; he is assistant director of technical services, Jones & Laughlin Steel Corp.

James A. Commins: Appointed vice president-marketing of General Atronics Corp., Philadelphia. He was formerly manager of marketing and administration.

H. Neal Karr: Appointed to head the newly-created Technical Products Div. of the Singer Co., State College, Pa. **Allen W. Drew:** To head the Special Products Div. Both men are vice presidents of Singer. **Donald D. Marsden:** Appointed Controller of Singer Co.

John E. Ebert: Appointed to the board of directors of Weinschel Engineering Co., Inc., Gaithersburg, Md. He is also vice president of engineering.

Arnold H. Glaser: Elected corporate vice president of Allied Research Associates, Inc., Concord, Mass. He is also president of the ARACON Geophysics Co. Div. of Allied Research.

Robert H. Davies: Elected a director and president of Sangamo Electric Co., Springfield, Ill. **Charles H. Lanphier:** Elected chairman of the board of Sangamo.

Marvin B. Ruffin: Appointed executive vice president and corporate general manager of Model Engineering and Manufacturing Corp., Huntington, Ind.

Colonel Robert E. Warren: Awarded the NASA Special Service Award. He is deputy director of the Communications and Navigation Programs Div. of NASA.

William D. Jobe: Promoted to vice president for engineering of Sigma Systems Corp., corporate division of Applied Science, Inc. **Royce C. Crossman:** Named manager of manufacturing and production.

Jerry F. Hansen: Appointed chief engineer of Phelps Dodge Electronic Products Corp., New Haven, Conn.

Frank V. Wagner: To be keynote speaker at the Third Annual UAIDE meeting in Los Angeles, Aug. 12-14. He is vice president, plans and programs, for Informatics, Inc., Los Angeles.

W. E. Boyce: Named chief executive officer of Molectro Corp., Santa Clara, Calif. **Edmund E. Farrell:** Elected vice president of marketing. **Desmond Spittlehouse:** Elected vice president in charge of operations and manufacturing. **Roland R. Mangiantini:** Elected treasurer.

Paul Dietz: Appointed commercial vice president of Allis-Chalmers, New York City.

David L. Douglas: Appointed director of research and development of Gould-National Batteries, Inc., St. Paul, Minn.

William M. Epes: Appointed manager of the Patent Dept., Pennsalt Chemicals Corp., Philadelphia.

Robert R. Donaldson: Named to head eastern regional sales and service activities of the data processing divisions, Consolidated Electrodynamics Corp., Pasadena, Calif.

Kenneth H. Bennett: Elected controller of Cutler-Hammer, Inc., Milwaukee, Wis.

William H. Zolides: Named manufacturing manager of Airtron Div. of Litton Industries, Beverly Hills, Calif.

Lewis A. Wodetski: Appointed manager of internal auditing of Oak Electro/netics Corp., Crystal Lake, Ill.

Charles C. Weston: Appointed controller of the International Resistance Co., Philadelphia.

—when and where

JULY

Seminar in Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries, sponsored by the Contract Measurement Institute, Savoy-Hilton Hotel, New York City, July 6-10.

International Symposium on Magnetohydrodynamic Electrical Power Generation, European Nuclear Energy Agency and the Institut National des Sciences et techniques Nucleaires, Paris, July 6-10.

Concentrated Vortex Motions in Fluids, AF Office of Scientific Research, ONR, NSF, NASA and the International Union of Theoretical and Applied Mechanics, University of Michigan, Ann Arbor, July 6-11.

20th Interagency Solid Propulsion Meeting, Sheraton Hotel, Philadelphia, July 12-15.

Aerospace Electrical/Electronic Supersonic Symposium, "Supersonic Aircraft—Avionics at Mach 3 and Beyond," Aerospace Electrical Society, International Hotel, Los Angeles, July 14-15.

Fourth International Symposium on Rarefied Gas Dynamics, sponsored by the AF Office of Scientific Research, ONR, NASA and the University of Toronto, Toronto, Canada, July 14-17.

Briefing Conference on Government Contracting for Research and Development, Federal Bar Assoc. and the Bureau of National Affairs, Statler Hilton Hotel, Boston, July 15-16.

Gordon Research Conference on Critical Tables and Progress in Science, Air Force Office of Scientific Research, New Hampton, N.H., July 20-24.

International Congress on Semiconductor Physics, sponsored by the AF Office of Scientific Research, NSF, ONR and the International Union of Pure and Applied Physics, Paris, July 20-24.

Meeting of the American Crystallographic Assoc., American Crystallographic Assoc., Montana State College, Bozeman, July 26-31.

Sixth International Symposium on the Reactivity of Solids, International Union of Biochemistry, New York Hilton and Americana Hotels, New York City, July 26-Aug. 1.

"Random Processes in Communication Systems," Polytechnic Institute of Brooklyn's Farmingdale Graduate Center, Farmingdale, N.Y., July 27-31.

AUGUST

First Research Conference on Instrumentation Science, Instrument Society of America, William Smith College, Geneva, N.Y., August 3-7.

Fifth International Symposium on the Reactivity of Solids, International Union of Pure and Applied Chemistry and International Union of Pure and Applied Physics, Munich, Germany, August 4-10.

12th Annual Engineering Management Conference, Institute of Electrical and Electronics Engineers, ASME, AIIE, and ISA, Pick-Carter Hotel, Cleveland, August 9-11.

Seventh National Heat Transfer Conference, American Institute of Chemical Engineers and American Society of Mechanical Engineers, Sheraton-Cleveland Hotel, Cleveland, August 9-12.

Structural Developments in Inorganic Chemistry and Their Chemical Implications, AF Office of Scientific Research, New Hampton, N.H., August 10-14.

Contracts Seminar, Department of Defense and the National Association of Professional Contract Adminlstrators, Orlando, Fla., August 10-13.

1964 Cryogenic Engineering Conference, University of Pennsylvania, Philadelphia, August 17-21.

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Cooperation with Europe

EUROPE AND THE UNITED STATES, despite a few bumpy spots in the ComSat talks, are moving closer together in space cooperation. That was very evident at the recent Rome meeting of the Eurospace industrial organization (M/R, June 29, p. 17).

Our chief European correspondent, Frank McGuire, reports an exceedingly frank and educational exchange between the Europeans and Americans present there.

The level of interest in the meeting was very high. Among those present were the ranking executives from Boelkow, Dornier, Junkers, Krupp, SEREB, Contraves, Fiat, Thomson Houston, Bristol Siddeley and many other firms of equal stature in Europe.

Only five papers were presented, all by Americans. Dr. Carl Kober, Martin Co., spoke on "Principles of Interface Management in Advanced Projects"; T. J. Gordon of Douglas Aircraft on "Cost Effectiveness in a Development Program"; Harold Rosen of Hughes Aircraft on "An International Commercial Communication Satellite System"; H. K. Hebeler of Boeing on "Integration Tools of System Management"; and Hilliard Paige of General Electric on "Environmental Testing for Spacecraft."

After each presentation, a panel of questioners composed entirely of Europeans took over to air a great many of the problems of U.S.-European cooperation in the space field.

It was clear that the Europeans have much to learn about the cost, size and complexity of space programming. They were aghast to hear the U.S. participants talking in terms of hundreds of millions of dollars per project. They were equally astonished to learn that there were 20,000 engineering changes on *Titan II*, requiring documentation to each of 2,000 subcontractors—a total of 40,000,000 items of paperwork.

Participants from both sides of the Atlantic were far more aware after the conference of the areas in which they have only a little understanding of each other's problems.

There is a strong new determination on both sides to keep the channels of communication clear and open. This is a necessity if the United States and Europe are to work together in space. Despite an understandable nationalistic desire to go it alone, the majority of Europeans realize that the sheer cost of space programs will force them into more participation with the U.S.

There will always be some pockets of dissension and these should not be unexpected. During the recent Communications Satellite Corp. talks in Europe, there was some resentment against a commercial U.S. firm dictating terms to European governments. This was a minority view, but American representatives in Europe must be cognizant of certain sensitivities there.

As Mr. McGuire views it, the complaints are reminiscent of similar rumblings against Space Technology Laboratories during the early days of the ICBM programs and before U.S. firms learned to live with the new systems management philosophy. Thus, they probably will fade with time.

One European put the desire for international space cooperation this way: "Let's face it. There's no vital reason for us to go into space any more than there was to build the pyramids or the Eiffel Tower. But since we want to do it, let's do it together instead of in three armed camps bankrupting each other. It's an expensive sport."

It is indeed an expensive sport. The conference heard with amazement the statement that the *Manned Orbiting Laboratory* may cost up to $1.5 billion for only six or seven launches. Many Europeans feel their programs simply will never be large enough to require the massive management effort, special task forces and PERT systems of the U.S. space program.

Nevertheless, they are equally aware that they run the risk of falling behind in technological progress as space technology spins off into other areas of direct economic benefit.

There was considerable interest, therefore, in large programs and how to manage them. Dr. Kober in his remarks about the subtleties of the interfaces between industry contractors, subcontractors and the government did much to enlighten his European colleagues about some of the more interesting pitfalls of program management.

Despite the nationalistic desires of such nations as France, we do not anticipate any massive space programs in the foreseeable future in Europe. This is true even when the broader-based European consortium efforts are considered. There is no large-scale market for U.S. management know-how or U.S. space products and there won't be for some time.

THERE WILL BE, HOWEVER, European participation in U.S. efforts—this already is fact—and there will be distinctly European contributions in such fields as scientific probes and satellites.

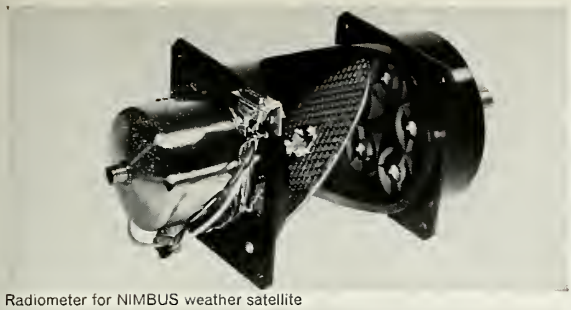
The Europeans have made clear their readiness, even if with minor misgivings, to participate in the ComSat project. Europe thus is beginning to crawl as it comes of age in space; it will be a long time before it walks and it is doubtful if it ever will run.

Nevertheless, the U.S. should do all it can to encourage this European interest. Some political problems may arise, of course. One cropped up at Rome. Since several East European countries have put out feelers to join the Common Market, the possibility exists that they may also express interest in Eurospace, particularly since they appear to have little to do with the Soviet space program.

This possibility, remote though it is, could raise some problems for the U.S. But these are difficulties which can be overcome as they arise. The U.S., already encouraging European participation in space through the National Aeronautics and Space Administration, should continue to do so.

The Rome conference was strong evidence that the interest is reciprocal.

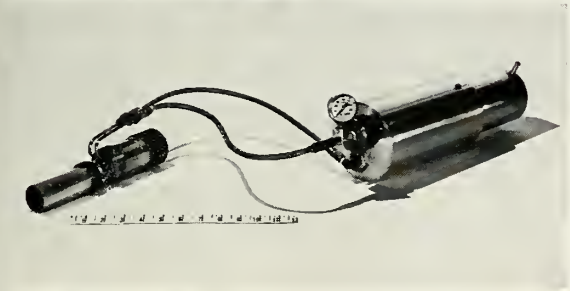
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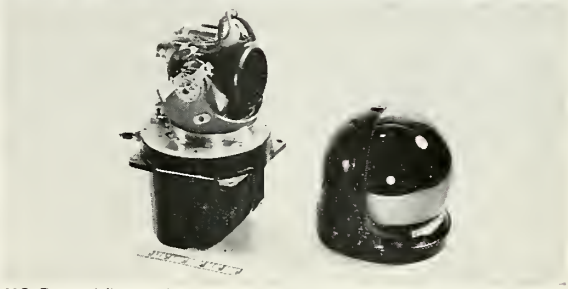
Radiometer for NIMBUS weather satellite



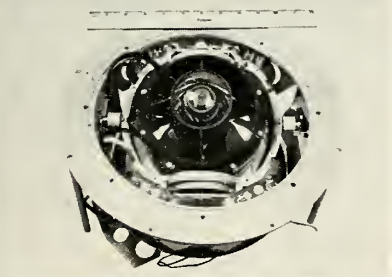
Interceptor IR installation



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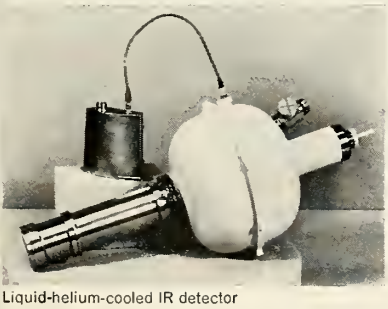
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GENERAL TIRE

JULY 13, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

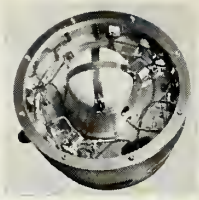


Prototype Project 465L Data Display Equipment at ITT

LASV Program Being Cancelled by DOD . .

New SAC C&C System Prototype Shown .

How Hercules Plant Meets Schedules . . .





HYDROGEN PEROXIDE CONTROL SYSTEMS FOR SPACE

Space-General's advanced capability in hydrogen peroxide propulsion systems was recently demonstrated on a vehicle flown to sample the earth's upper atmosphere for nuclear debris. In its first flight test, the spin system fully met the operating specifications. The program—directed by the Sandia Corporation for the Atomic Energy Commission's Division of Biology and Medicine—is being developed to sample the atmosphere above 100,000 feet for debris dispersal. Boosted by an Honest John-Nike Rocket System, the sampling vehicle contains rotor blades which unfold at the start of the descent and extract particulate matter from the air. Uniform spin of the rotor blades, commencing at an altitude of approximately 190,000 feet, is maintained by a hydrogen peroxide propulsion system and special control package. ■ The simple, high performance propulsion system and the control system, utilizing photo cells to accurately count the number of rotor blade revolutions, were designed and developed by the men of Space-General. ■ Space-General's pioneering development of hydrogen peroxide propulsion systems is the result of a total systems—and team—approach. Systems-oriented men, seeking unusual challenge, are invited to apply for a position on this, or other, Space-General teams.

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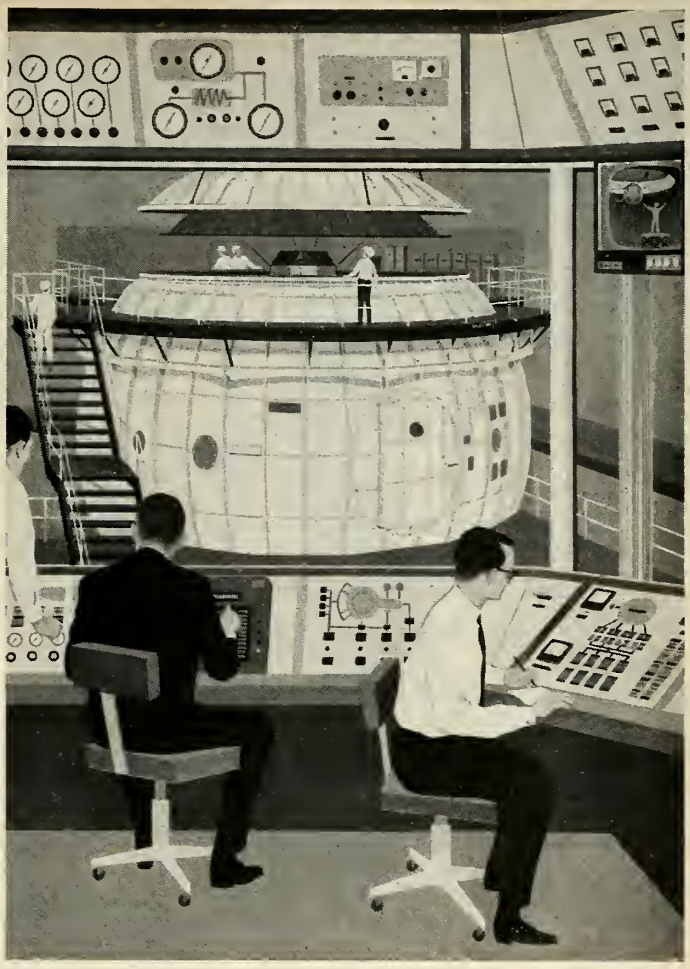


BIG-ROUND-TALL

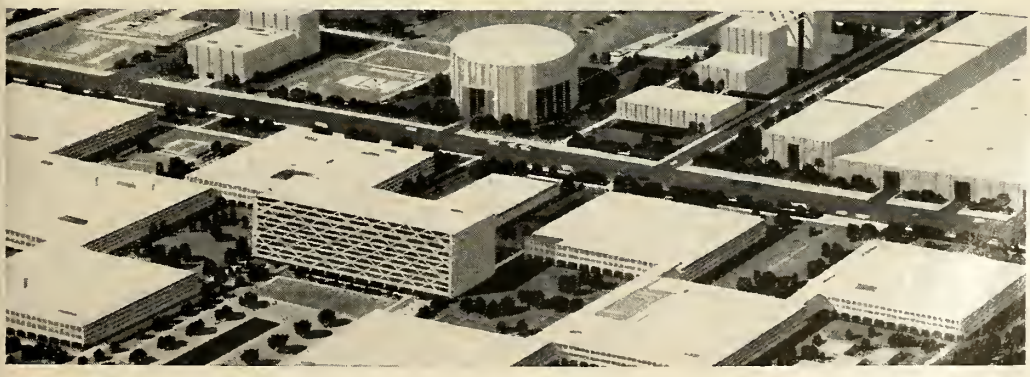
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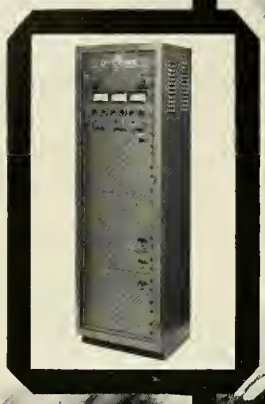
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COMPARE magnetic fields with a closed-loop control console that applies a calibrated reference current to the reference winding of the probe so an induced, comparable magnetic field is developed about a probe element.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 15, Number 2 July 13, 1964

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THE COVER



Data Display Central (DDC), Project 465L, prototype equipment is shown as it was publicly unveiled for the first time by ITT's Data and Information Systems Div. test facility. SAC is expected to have operational system in mid-1965. See story, p. 18.

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Wiancko has a heart for instrument systems

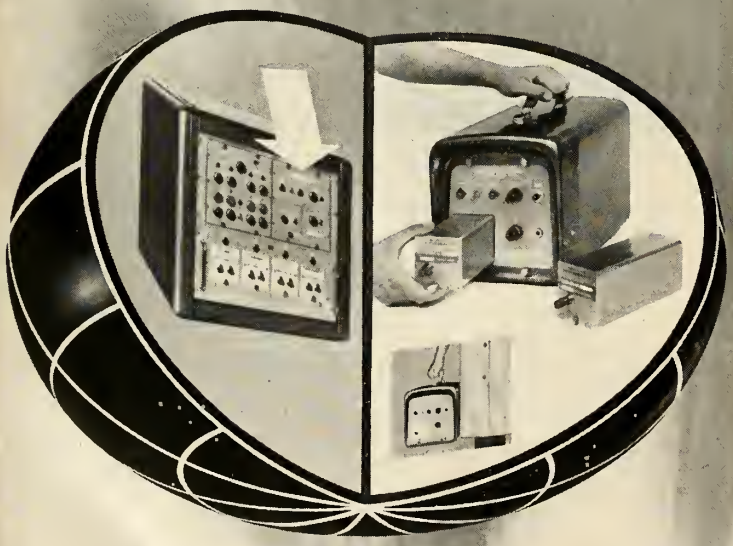
Specifically for the heart of instrumentation systems, many of which can be assembled on a do-it-yourself "building block" basis, Wiancko has developed units such as Secondary Standard Q3403, Digital Pressure Generator Q3700, and High-Accuracy Pressure Measuring Unit M1100.

Secondary Standard Q3403, for example, is an unusually versatile unit which can, through the use of interchangeable plug-in accessories, measure pressure, force, acceleration, or other parameters to ±0.05 percent accuracy, and provide an output in digital form. Extremely flexible in design, this portable unit can be used in the field or the laboratory, or can be integrated into complete instrumentation systems, typically performing direct parameter measurements or on-line calibration of gauges and transducers.

Reflecting a similar modular concept, Digital Pressure Generator Q3700, providing precision pressures accurate to ±0.05 percent from an unregulated source, can be used as the heart of an automatic equipment for checkout and calibration of a complete instrumentation system. High-Accuracy Pressure Measuring Unit M1100, supplying an analog output, could function as the central unit in a precision pressure control system.

For complete details of Wiancko's modular concept in instrumentation systems for diversified applications, contact Mr. Bob Backus, Manager of Field Engineering, Wiancko Engineering, 255 North Halstead Avenue, Pasadena, California. Phone: MUrray 1-4471. A Division of Tamar Electronics, Inc.

WIANCKO



THE MANY WORLDS OF TAMAR • WIANCKO / AMERICAN GYRO / STODDART / ECONOLITE

letters

Invention and Aggregation

To the Editor:

The letter of John H. Bloomer ("Inventors Should Organize," M/R, June 22, p. 6) appears to be emotional, and this is understandable.

However, it is only fair to understand that since American inventors obtained their knowledge in the United States without hindrance from government agencies, their first loyalty should be to the United States of America.

Most inventors believe that aggregation is invention, which is incorrect; and very soon they will have the opportunity to test their ability, in view of the substantial decline in government contracts which is compelling many large companies to adopt the three-step parallel competitive system for developing new products.

In the first step, financial losses are minimized by eliminating engineers and grandiloquent supervisors lacking creative background, and retaining on the payroll only those engineers whose employment records show proof of creative ability attested by at least one pending patent application in the field of their endeavors.

The second step involves retaining a reputable law firm specializing in patents, for analyzing and disclosing the "holes" in the patents of the successful aerospace companies.

In the third step, the creative engineers mentioned in the first step roll up their sleeves and burn the midnight oil to develop the subject-matter of the said "holes" into new products that are competitive with the products of the successful companies, after which it is incumbent on sales departments to market the new competitive products.

Obviously it takes more than inventors to operate a successful company.

Harry Bricker Fuchs
Farmingdale, L.I., N.Y.

Tyminski Speech

To the Editor:

I have read with interest your June 29 editorial, and especially note the excerpts from the speech of Mr. Walter V. Tyminski, President of Belock Instrument Corp.

Could you provide me with the complete text of his remarks?

Carlisle Burns
General Electric Co.
Missile and Space Div.
Valley Forge Space
Technology Center
Valley Forge, Pa.

Copies of Mr. Tyminski's speech may be obtained by writing to Mr. Don Alt, Belock Instrument Corp., College Point, L.I., N.Y., 11356.—Ed.

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Boeing's Airplane Division is located near Seattle in the uncongested Pacific Northwest, noted for year-round mild climate, nationally famous recreational facilities, excellent schools and housing, and healthful outdoor Western living for the whole family.

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POT-POURRI

Published monthly by Giannini Controls Corporation to advance our belief that the truth need not be dull.

THIS MONTH:

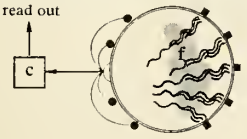
NUCLEAR MEASUREMENT OF WEIGHTLESS FUEL
WORLD'S SMALLEST PRESSURE X'DUCER
SALES GROUP DESIGNS SPACE CAPSULE
LETTERS TO THE EDITOR

WEIGHTLESS FUEL IS A PROBELEM

When a space vehicle's fuel tank goes weightless, probe-type measurement devices go non-operational. At zero-G, fuel just meanders around the tank in globules, droplets or mist. And you just can't measure an amorphous or moving mass with a fixed probe.

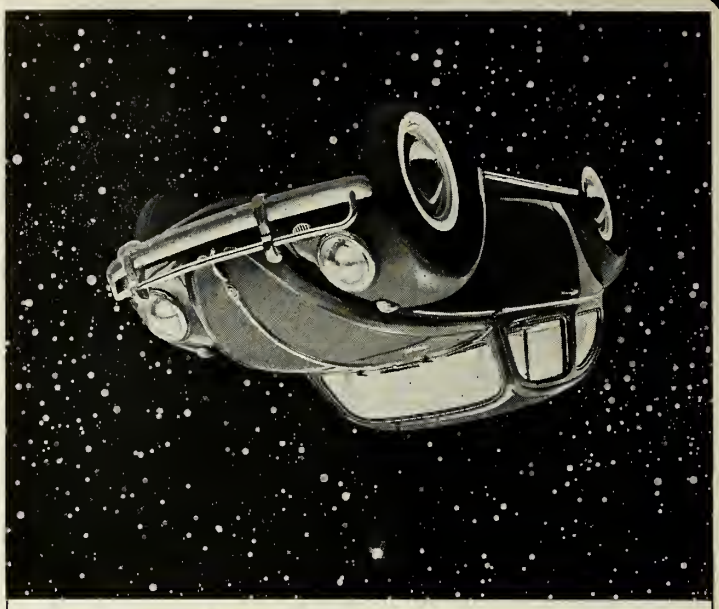
The men of our Control/Nucleonics Division, firm in their belief that there's a radiological answer for everything from dandruff to Mau-Mau, recently laid the weightless fuel problem to rest. Here's how:

The drawing below represents a cross-section of a space vehicle's fuel tank at



zero-G. The fuel (f) is a free-floating puddle inside the tank. The little squares (▪) at the right of the tank are sources emitting radiation. The dots (•) around the other side are scintillators which detect radiation levels. As the radiation (≋) from the sources passes through the fuel, it loses intensity in ratio to the fuel's mass. So, the scintillators see less radiation than the sources emit. This reduction in intensity, when fed through a miniature GCC computer (c), gives an accurate, continuous reading of fuel residuals, regardless of attitude or G-loadings. Also, note that our hardware is completely external, with no internal plumbing to get honked up. Simple, isn't it?

OK, gang. Now, how about dandruff?



DAS VIER MAN VOLKSKAPSEL, MARKE IV

Ever ask yourself how sales engineers would tackle a major design problem? Wonder no more. Above you see a space capsule. It comes from a group therapy session chaired by Tucker Benz, erstwhile GCC systems seller*.

Behold the Volkskapsel. What it lacks in concept, it gains in raw saleability. Look at that configuration. They'd love it in Huntsville. Regard the $1695 POE price (not including fuel gauge described at left). How could Congress object? As for the tax-paying public, at last they'd have a space project they could identify with. As for the Astronauts, well . . .

For a rendering of the Volkskapsel, drop us a line care of T. Benz.

LETTERS TO THE EDITOR

Dear Editor,

I object to how we name ~~[illegible]~~ space projects.

For instance I bet you don't know that Apollo came from a mixed up immorale family. Well he did and his father Zeus was a nut who went around tossing thunderbolts at anybody he didn't like and his mother Latona never even got married to Zeus and Apollo hung around a lot with satyrs and centaurs and show business people like that.

Also there was Apollos own son who got his hot rodding delinquent hands on Apollos sun chariot one day and burned up the equator and froze both poles so Zeus got mad and killed the kid with a thunderbolt. ~~and [illegible]~~

If we got to name our space stuff after people like these why not use Tennessee Williams characters? At least theyre Americans. Mad Taxpayer

PS I bet you don't print this!

*In reward for his great systems knowledge, Mr. Benz has been elevated to Marketing Mgr. of GCC's Instrument Division.



CUT PRESSURE X'DUCER PAYLOADS 1/3

We've carved ½" and 2 oz. out of our miniature 1½" pressure transducers. The results are the smallest, lightest potentiometric transducers in anybody's inventory.

Stable at 75 G's

These new midgets come in both high and low pressure versions covering 0 to 3,500 psia. Weight is 3 oz. Temperature range is −65°F. to +200°F. They're stable at 50 G's vibration and acceleration (up to 75 G's for the high pressure version). Impressive? It's a small wonder!

MORE DATA *For additional information, use these reader service #s:*
Fuel gauging 10
Midget x'ducer 11

GIANNINI CONTROLS CORPORATION
1600 South Mountain Avenue, Duarte, California

The Countdown

WASHINGTON

And the Body Isn't Even Cold

The day after Director of Defense Research and Engineering Dr. Harold Brown signed the letter to the Air Force informing them of his decision to cancel the *LASV*/Pluto program (see p. 16), Lockheed Missiles & Space Co. gave a presentation to the Air Force on the *Chemical Low-Altitude Missile (CLAM)*. Navy is interested in *CLAM* but until now the Air Force hasn't shown much interest.

LEM Descent Engine Contest Extended

NASA is going to continue until December parallel development of the Lunar Excursion Module's descent propulsion system by TRW Space Technology Laboratories and Rocketdyne Div. of North American Aviation. It had hoped to pick one of the two firms to develop the system this month, but they are so close together the agency couldn't decide who was ahead. Additional tests and work will continue, therefore—and both companies will receive more funding.

Need for Post-Saturn V Booster Outlined

Marshall Space Flight Center planners now believe a post-*Saturn V* booster will be needed if the U.S. undertakes a manned planetary exploration program. They also favor the so-called Block II vehicle, which would have two stages using new propulsion techniques and high-pressure engines. First stage would be recoverable. Requirement for the booster is based on studies of the future National Space Program. These indicate that a small program would cost an average of $3.88 billion per year between 1970 and 1990. It would include 10 space stations, a 12-man lunar base, 18 unmanned planetary flights and eight manned planetary missions. A large program would average $6.67 billion a year in the 20-year period; it would provide 24 space stations, an 80-man lunar base, 37 unmanned planetary missions and 11 manned planetary flights.

New Tracker for Alaska BMEWS Site

The Air Force has asked the electronics industry to build an extra tracking radar for the Clear, Alaska, Ballistic Early Warning System (BMEWS) site. Proposals are due at Electronic Systems Div. of the AF Systems Command by Aug. 17; the 496L/474L system program office is in charge of the project. ESD is seeking a radar with capabilities like those existing at the other BMEWS sites, in Greenland and England. It will both improve BMEWS coverage and add another facility to ESD's space track system, giving more detailed information on orbiting satellites.

More Centaurs About to Be Ordered

A follow-on contract for eight to 10 more *Centaur* space vehicles is expected to be signed by NASA and General Dynamics/Astronautics. The award will include incentive provisions—a further step in the agency's broadening use of such contracts.

ERC Boss To Be New in NASA

Announcement of the name of the director of NASA's new Electronics Research Center is imminent. While identity of the selection is still secret, it is known that top management has by-passed current NASA electronics officials and gone outside the agency to pick their man. Meanwhile, it is also reported that Administrator James E. Webb has asked the mayor of Cambridge to brief him as to whether two sites in that vicinity are available as locations for the center, which will be built in the Greater Boston area.

Next Ranger Shot Due Shortly

The *Ranger VII* spacecraft is now scheduled for launch on July 27. The lunar hard-landing spacecraft was recently trucked to Cape Kennedy, where it is undergoing preflight checkout and testing. There is a five-day launch window extending until Aug. 1.

INDUSTRY

Thiokol Lands $19-Million Bullpup Order

The Navy's total procurement of *Bullpup* AGM-12C engines for Fiscal 1965 will be produced by Thiokol Chemical Corp.'s Reaction Motors Div. under a $19.928-million BuWeps contract. The same order also includes the LR62 packaged liquid engines for the Air Force *Bullpup*. Thiokol recently won a competitive contract totalling nearly $3.5 million to continue production on the smaller *Bullpup* AGM-12B missiles.

Rocketdyne To Furnish NERVA Nozzles

Four RN-6 liquid hydrogen-cooled nozzles will be delivered to NASA under a cost-plus-incentive-fee agreement expected to total $1.3 million. Three of the nozzles will go to the *NERVA* program at the joint NASA-AEC facility at Mercury, Nev., and the fourth will be used in the NASA Lewis Research Center Advanced Nuclear Rocket Systems Analysis Program at Plum Brook, Ohio. All four are test units.

Martin Ahead of Cost-Cutting Schedule

Martin Co. reports it achieved documented cost reductions of $33.8 million on defense and space contracts in the first half of calendar 1964—well on the way toward its cost-reduction goal of $55 million for the full year. Total reductions at operating divisions were listed as: Denver, $20.7 million; Orlando, $9.5 million; Baltimore, $3.1 million; and Canaveral, $500,000. The company has documented more than $300 million in savings on government work since it set up its organized cost-cutting program three years ago.

INTERNATIONAL

SNECMA-Nord in Missile Deal

SNECMA, the nationalized French engine manufacturing company, has disclosed that it has signed an agreement with Nord-Aviation to manufacture metallic casings for high-power rocket powerplants for ballistic missiles. The company's annual report says it is making metal parts for *Hawk* engines, and parts for Vexin engines for the *Diamant* satellite launchers.

Cost isn't the only advantage of UTC's 120-inch solid propellant segments



SUBJECT: 120-INCH SOLID PROPELLANT ROCKET SEGMENTS AS BASIC POWER UNITS

Company: United Technology Center

Background:

The segmented 120-inch diameter solid propellant rocket motor is being developed for the Air Force by UTC. Two five-segment motors will be used as the booster stage of the Titan III-C.

Advantages:

The 120-inch segments are simple, reliable, versatile, basic power units.

They can be mass-produced in present UTC facilities, easily transported, and can be stored for long periods of time. At the launch site, they can be rapidly assembled into a variety of configurations.

Because of the adaptability of these segments, they have numerous applications. Assembled into complete motors, they can be used for advanced ballistic missiles to increase payload and range, and for thrust augmentation of larger vehicles. Clustered, the solid rocket motors can be used for complete missile and space launch systems.

Clustering of 120-inch segmented solid propellant rocket motors will enable UTC to meet future space needs by providing vehicles capable of thrusts in the range of 20 million pounds without extensive development programs or facilities expansion.

Further reference: write UTC, Sunnyvale, California

United Technology Center DIVISION OF UNITED AIRCRAFT CORPORATION

McNamara Reports Savings

Savings of $2.5 billion have been realized in the Defense Department during FY '64—more than $1 billion more than was forecast last year—as a result of the cost reduction program initiated in 1961.

These annual savings are expected to increase to $4.6 billion per year by FY '68, an increase of $600 million over earlier projections.

The figures were revealed in a memorandum from Secretary of Defense Robert S. McNamara to President Johnson. McNamara also held a lengthy news conference in which he outlined specific instances of savings for reporters.

He singled out the *Titan III* contract with the Martin Co. as probably one of the best-managed contracts DOD has as a result of the incentives applied to the program. The contractor, he said, could earn from $6 million to $35 million depending on his contractual performance. As a result, spending on the program—which to date totals $173 million—is 1% below the cost estimate. The number of engineering changes is probably the lowest under any DOD contract, and significantly, the program is on schedule.

More encouraging than the fact that the projected cost reduction goals were exceeded, McNamara said, was the fact that "cost consciousness is beginning to permeate down through the department." Thousands of suggestions are being received from DOD employees on ways to reduce costs, the Defense Secretary said. He felt he was underestimating savings that will be realized through the program.

Savings are validated by 285 auditors operating independently of the Assistant Secretary of Defense for Installations and Logistics, who is responsible for the program. In fact, McNamara said, the auditors had thrown out about $500 million in reported savings they could not verify.

Firms Get $50M for Apollo

Douglas Aircraft Co. and Rocketdyne Div. of North American Aviation, Inc., have received additional project *Apollo* work worth a total of more than $50 million.

The space agency announced that Douglas will receive more than $30 million including a $10,250,000 contract extension for further work on the S-IVB third stage of the *Saturn V* booster and $21,221,836 contract extension for engineering changes and further R&D work on the S-IV second stage of the *Saturn I*.

Rocketdyne's contract changes call for an additional $22,378,626 for four modifications in its work on the F-1 engine.

DOD Stresses Logistics Role

Logisticians have been given an important and permanent role in the acquisition of military weapons systems. Under a Defense Dept. directive (4100.35) effective June 19, experienced support personnel will be assigned to a development project from its inception "to assure that integrated logistic support is planned and acquired in an orderly and systematic manner."

Initiated by the Director of Logistics of the Joint Chiefs of Staff, the directive is aimed at minimizing support costs by placing strong emphasis on logistic and maintenance requirements during the development and production phases of systems development.

In addition to avoidance of excessive costs, however, an even greater potential is seen for increased readiness of weapon systems in the field.

The directive calls for development of an integrated logistic support plan "concurrently with the performance reqirements or at the earliest possible time in the conceptual phase and at the procurement planning phase for commercially available items."

DOD Studies CPE Extension

Extension of the Defense Department's Contractor Performance Evaluation program to other areas of military procurement is under consideration by a DOD working group. The program has already been broadened to include not only engineering and operational systems developments but also advanced development projects "where there are identifiable goals."

The working group, under sponsorship of the Assistant Secretary of Defense for Installations and Logistics, is expected to make its recommendations by the first of the year. Basically, the group is considering extending Contractor Performance Evaluation (CPE) (M/R, 9/16/63, p. 31) to areas "largely out of the research and development area." The feasibility and practicality of applying CPE to production contracts is expected to be one of the results of the working group's efforts.

CPE now applies to R&D contracts in the three major categories in which $5 million per year is expended or in which $20 million is spent over the life of the contract.

DOD officials are pleased with the results of the first round of CPE evaluations, which have just been concluded. Periodic reports are being submitted by project managers on 41 contractors covering 24 different development programs.

The reports are fundamentally sound and objective, an Installations and Logistics official told MISSILES AND ROCKETS. Some changes in the program are now being staffed, he said, but these deal primarily with the "mechanical" process of how to fill out the report. The Defense Industry Advisory Council will review these changes, however, before they are implemented.

Largest Monolithic Solid Poured

The largest monolithic solid grain ever poured is now well into its 20-day curing cycle at Aerojet-Dade Div. of Aerojet-General Corp. The 120-in., 37-ft.-long "Subscale 1" will be test fired in the same cast-pure pit in mid-August.

Both batch and continuous mix processes were used with the continuous mix working for 55 straight hours in the 2½-day pouring job. The 100-ton grain will produce about 600,000 lbs. thrust in checking out the nozzle, materials and processes developed for the upcoming 260-in. large solid rocket test at Aerojet (M/R Dec. 2, 1963, p. 29).

Adm. Ricketts Dead

Adm. Claude V. Ricketts, Vice Chief of Naval Operations, died July 6 at the U.S. Naval Hospital, Bethesda, Md. He had entered the hospital July 3 following a heart attack. Ricketts' chief job in recent years has been persuading European governments to accept the U.S. idea of maintaining a force of ships equipped with nuclear weapons and manned by multinational crews from NATO countries, the MLF concept.

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Solids Lead in Volume I_{sp}

With the advent of ever larger booster systems the common display of specific impulse as pound-seconds of impulse per pound may give way to a comparison on a volume basis of I_{sp}.

Richard F. Cottrell, Asst. Manager, Solid Rocket Plant, Aerojet-General Corp., says it is the specific impulse of propellants on a density basis that fundamentally determines the physical size of propulsion systems.

Physical size, says Cottrell, governs the size and cost of support facilities and other ground equipment such as launch towers. Solid propellants in use today—*Polaris, Minuteman* and the 260-in. solid booster program—have volume specific impulses in the 15.5 to 16-lb.-sec./cu. in. range. This compares with 3.5 to 3.6-lb.-sec./cu. in. range for LOX-hydrogen.

This high density of solid fuels, says Cottrell, allows designers to create large solid boosters only 25% of the size of those using LOX-hydrogen for the same mission. A 260-in.-dia. LOX-hydrogen space booster would be four times the length of the solids now being built—or over 300 ft.

SOLID PROPELLANTS	Density	Std-Sea level Isp lb-sec/lb	Vol. Isp lb-secs/in³
Minuteman, Polaris	—	243–	15.5–
AF-NASA 260 Program	0.063–.064	249	15.9
LIQUID PROPELLANTS	(Pressure rates 1000/14.7, Area ratio optimum, 95% efficiency)		
Lox—Hydrogen	0.00954	371	3.54
Nitrogen Tetroxide/ Aerozene 50	0.0430	273	11.8
Lox—Kerosene (JP-4)	0.0368	285	10.5
Flox—Hydrogen	0.0139	390	5.43

The effect of this factor on facility cost is obvious, comments Cottrell. He said that the vacuum I_{sp} of solids is in the 17 lb.-sec./cu. in.—still above that for the liquids.

ComSat Nominates Six

The board of directors of the Communications Satellite Corp. has nominated six men for election to the organization's new board, which will be formed at the first annual stockholders meeting next fall.

The nominees, who, if elected, will represent public shareholders as company directors, are Joseph V. Charyk, president of ComSat Corp.; David M. Kennedy, chairman of Continental Illinois Bank and Trust Co.; George Killion, president of American President Lines; Leonard H. Marks, an attorney; Bruce G. Sundlun, an attorney; and Leo D. Welch, chairman and chief executive of ComSat Corp. All are serving on the corporation's current board.

Another six board members will be elected by the communications common carriers that own stock in the company, and the remaining three board members will be appointed by the President, with the advice and consent of the Senate.

Moondust Power System Studied

An analysis of possible power-generation and propulsion through the use of charged particles, or colloids, is being performed by the Pasadena Research Div. of Maremont Corp. The Navy Bureau of Weapons contract calls for a preliminary program leading to eventual systems development. The system, if feasible, would be more efficient and lighter than present concepts and could serve as the central power generator for a wide range of spacecraft and astronaut devices. Nuclear energy would be used to create thrust through a beam of tiny charged particles—and Moon or planetary dust could serve as fuel.

Closed-Loop MHD at WEC

A system combining a magneto-hydrodynamics (MHD) generator and an MHD motor into a single closed loop is in operation at Westinghouse Research Laboratories.

Developed under funds from the Air Force Aero-Propulsion Lab, Flight Vehicle Propulsion Div., Wright-Patterson AFB, Ohio, the high-temperature MHD motor is essentially an MHD generator operating in reverse. It compresses the plasma and feeds it to the generator, where, passing between the poles of a strong magnet, it generates electric power. The helium-cesium plasma mixture has a maximum temperature of 3,500° F and is kept at the operating temperature by electrical heating. Small amounts of the plasma components are added to keep the pressures and concentrations correct.

The loop has been run for a total of 8.5 hours in two checkout tests. Experiments aimed at kilowatt-level power production are planned for the near future.

Single Picket Strikes Cape

Teamster Union President James Hoffa intervened to remove a single Teamster picket whose presence prompted 1,507 Merritt Island Launch Area workers to stay away from work one day early last week.

The unidentified picket was striking over a dispute between the Teamsters and a Miami rock-and-concrete supplier furnishing materials for the crawlerway connecting the Vertical Assembly Building and launch pad for *Saturn V*.

TWA To Provide MILA Support

Trans-World Airways, Inc., will receive $7,930,183 for the first 12 months of a three-year contract to provide support services at NASA's Merritt Island Launch Area.

The firm was selected by NASA to negotiate the contract last March. Amount is believed to be open to further definition each year.

TWA now has 700 employes and is expected to increase the number to 1,300 by the end of the first year of operation.

Universal Engine Sought

A feasibility study and demonstration of four bi-propellant, 100-lb.-thrust chambers will be performed by Bell Aerosystems Co. in an effort to develop a universal auxiliary rocket engine. The $788,838 NASA contract grew out of the Textron subsidiary's earlier work with 100-lb.-thrust, radiation-cooled chambers. The earlier tests proved the effectiveness of refractory metals such as columbium in rocket engines. The prime objective of the NASA work is the development of a rocket engine with durability independent of the mode of operation—whether continuous or pulse mode. The overall objective includes high performance and reliability coupled with minimum operating temperatures.

ARC Shows Beryllium Safety

Engineers at Atlantic Research Corp. have moved highly toxic beryllium powder propellant technology from the laboratory through pilot plant development to large-scale motors weighing thousands of pounds without a single disabling injury.

The program involved is the $2.5-million *PALLAS* project—formerly known as *Big X*—and covered test firings of from 0.25 lbs. of propellant all the way to the largest solid rocket ever built by the firm.

In a talk delivered before the recent President's Conference on Occupational Safety, ARC's Senior Vice President Keith E. Rumbel described the elaborate and intense safety campaign waged by the firm in its beryllium work.

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In his specific example, Rumbel referred to a typical formulation including dry, powdered nitrocellulose, liquid plasticizer similar to nitroglycerine, ammonium perchlorate powder and dry beryllium powder. The ingredients are mixed with other relatively inert components to a semi-fluid form, which is then poured and cast into a rocket case. The toxic nature of the beryllium combined with the explosive characteristics of the rest of the mixture posed a major safety problem.

Roadrunner Gets $5.5M

The Columbus Div. of North American Aviation, Inc., has received a $5.6-million contract for production of the *Roadrunner* target missile system.

The award from the Army's Missile Command, together with an earlier tooling and engineering contract, brings NAA's *Roadrunner* moneys to $7.5 million.

Roadrunner is the low-level version of the Columbus division's higher altitude *Redhead Roadrunner* target missile.

Shots of the Week

The *Polaris A3* test program came to an end July 2 with a land-pad launch from Cape Kennedy. The 2,500-mi. flight marked the 41st launch of the advanced *Polaris* since the test program was begun in the summer of 1962. The nuclear powered submarine Daniel Webster, which recently completed its test firings off the Cape, is scheduled to go on operational patrol late this summer with a full load of 16 *Polaris A3* missiles.

- On July 6, the Air Force lanched an *Atlas-Agena* bearing a payload of undisclosed type—possibly a *SAMOS* "spy-in-the-sky" satellite.
- The Air Force fired two *Minuteman* missiles within 30 minutes from silos at Vandenberg AFB, Calif., July 7. The first successfully completed a 5,000-mi. flight down the Pacific Missile Range, but the second was destroyed within seconds of the time it was launched. Cause of an apparent guidance malfunction in the second missile was not determined.
- NASA test pilot Air Force Capt. Joe Engle flew the no. 3 model of the *X-15* rocket plane from Edwards AFB, Calif., on July 8. Engle reached an altitude of 170,000 ft. and a speed of 3,511 mph during the test of the craft's horizon scanner.
- The "gold crew" of the *Polaris* submarine John Adams successfully launched three *A2* versions of the missile while submerged 30 mi. off Cape Kennedy July 8.

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3. **Flight Mechanics** — Experience in trajectory analysis, orbital mechanics, dynamic stability, de-orbit techniques. Physics, AE, ME, Engineering Mechanics.

4. **Systems Analysis** — To perform preliminary system optimization studies through subsystem tradeoffs. Define performance requirements and specific interface relationships between subsystems. EE, ME, Physics.

5. **Guidance & Control** — Responsible for systems analysis, synthesis, mechanization, and/or hardware design for advanced guidance & control concepts. Requires established systems background emphasizing creative analysis and design. EE, AE, ME, Physics.

6. **Communications Systems** — Design, analysis and synthesis of new instrumentation and communication systems requiring analytical knowledge of communications. EE, Physics.

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DOD Decides to Cancel LASV

Dr. Brown writes Air Force about decision; CLAM still under study; some sharp reaction expected from Capitol Hill

by James Trainor

LOW-ALTITUDE Supersonic Vehicle (*LASV*) program will be cancelled by the Department of Defense. Formal notification of the decision is contained in a July 6 letter to the Air Force signed by Dr. Harold Brown, Director of Defense Research & Engineering.

Brown notified the Atomic Energy Commission of his decision not to support the flight-test program of the Pluto nuclear ramjet engine last week. AEC reportedly has already begun terminating the Tory II-C program and laying off personnel. Initial steps are being taken to dismantle the reactor.

Except for the *Chemical Low-Altitude Missile* (*CLAM*), the concept of a strategic supersonic ramjet for strike and reconnaissance missions is no longer to be pursued. Interest in *CLAM* is centered almost exclusively in the Navy, where it is only one of many systems under consideration by the Advanced Sea-based Deterrent study group.

● **Reasons why**—Main reason for cancellation of the *LASV* is the lack of a specific military requirement for the missile. Until now, the program has been kept alive by "strong expressions of interest" by DOD and Air Force. However, with the Tory II-C ground test reactor exceeding expectations in a full-powered run, the next logical step was a flight-test program, which would be prohibitively expensive if there were no specific military requirement for the missile.

Subsidiary considerations were political. Some government officials felt that the initiation of a new strategic weapons system by the U.S. during the curent thaw in international tensions would prejudice continued good relations and would be misunderstood by the Russians. Also, since there would be some fallout from the missile in flight, some government officials felt that a flight-test program might violate, or could be interpreted as a violation of the nuclear test ban treaty.

On technical grounds, an argument can be made, and indeed has been, that once the reactor design has proven itself in a full-scale ground test, the technology can then be placed on the shelf against a future need. However, most people connected with the program do not feel that this is a valid argument. The Air Force position is that it does not consider the technology proven without a flight-test program.

Sources close to the program were surprised at the abrupt about-face by DDR&E. Until the middle of June, the indications had been that DDR&E was in favor of the flight-test program. Since then, however, the Defense Research and Engineering staff has been taking an opposite tack.

● **Rumble on Hill**—Congressional reaction to the cancellation—particularly among members of the Joint Committee on Atomic Energy—is expected to be violent. Although M&R could not verify it before deadline, one source told the magazine that the JCAE had tentatively scheduled hearings on the *LASV*/Pluto cancellation for July 20 and 21.

Rep. Chet Holifield (D-Calif.) told MISSILES AND ROCKETS he had "fought hard for the program and had appealed to the Secretary of Defense and Dr. Brown as did the chairman of the subcommittee" on Research and Development, Rep. Melvin Price (D-Ill.). "It was one program that was ahead of itself technically," Holifield added, "but the committee feels that we can't go any further" without a military requirement.

Holifield said that he did not know of any hearings but added he was not chairman of the subcommittee. It was Congress which precipitated the decision by cutting the AEC budget to a level that would not sustain even a ground-test program. Specifically, the House Appropriations Committee reduced the Pluto budget from $6.5 million in FY '65 to $1 million "for the purpose of 'moth-balling' the project until such time as there is a military system and a requirement for it."

The JCAE had not been as severe, cutting only $1.5 million from the request for work on a more advanced, Tory III reactor. However, the committee warned then that "unless a decision is made within the next year to flight-test the Tory II-C device, it is an unavoidable conclusion that the program should be terminated."

● **Costs**—A flight-test program has been estimated at $200 million for four vehicles and $500 million for 14 flight vehicles. Even after the expenditure of this amount, however, only the technology of the supersonic nuclear ramjet would have been demonstrated and a development program for an operational missile, if the requirement then existed, would have been needed.

Flight tests of the nuclear ramjet were to have been conducted from a launch site on the Kwajalein Atoll, with the test vehicle being blown apart after the test so that the radioactive components would sink in the Pacific.

Through Fiscal Year 1963, $167.0 million had been spent on *LASV*/Pluto, with the AEC contributing $124.4 million and the Air Force $42.6 million. An additional $29.0 million was budgeted in FY '64—$15 million AEC, $14 million Air Force.

Figures on how much of this was actually expended are not available. Presumably, the FY '65 cut in the AEC budget will now be sustained by the Senate and the $12 million in the Air Force budget for *LASV* eliminated.

Principal contractors for the LASV/Pluto are the AEC's Lawrence Radiation Lab for the nuclear reactor, Ling-Temco-Vought for the airframe and hardened avionics, and Marquardt Corp. for propulsion. Lockheed missiles & Space Co. is funded for the *CLAM* studies. ■

SERT I Shot Is Key Step In Ion Engine Development Effort

THE SPACE AGENCY will attempt its first flight test of ion engines this week.

Launch of the *SERT I (Space Electric Rocket Test)* with a *Scout* booster from Wallops Island, Va., is scheduled for no earlier than July 18.

Two experimental engines will be tested during the flight—a Lewis Research Center electron bombardment engine using mercury as a propellant, and a Hughes Aircraft Co., contact ionization engine using cesium.

Prime purpose of the ballistic shot of the 375-lb. *SERT I* is to verify that ion engines can produce thrust in space. This will be possible only if the positive ion exhaust beam can be effectively neutralized.

The neutralization will be attempted by injecting a stream of electrons into the ion beam as it moves out of the back of the engine. While this has been accomplished in ground vacuum tests, such experiments are not conclusive because electrons can escape out of the side of the vacuum chamber.

If the *SERT* flight is successful, development of ion engines can continue in ground chambers. If beam neutralization is ineffective, a new program of gound and flight tests may be initiated.

The *SERT* project is managed by NASA's Lewis Research Center. The payload integration contractor is RCA's Astro-Electronics Division.

Ion engines are candidates for propulsion systems for deep-space missions if lightweight nuclear electric power systems in the high-kilowatts-to-multimegawatts power range can be developed.

● **Engine description**—The two test engines have exhaust velocities greater than 100,000 mph, resulting in specific impulses of 8,050 sec. for the Hughes engine and 4,900 sec. for the Lewis engine. While the thrust of the engine is small (.001 lb. for the Hughes and .006 lb. for the Lewis), it is sufficient to study ion-beam ionization.

In the Hughes engine, the cesium is vaporized in an electrically heated boiler. The vapor flows through an electrically heated porous tungsten ionizer where the neutral cesium atoms are ionized when they touch the hot tungsten surface. The electrons stripped from each cesium atom are trapped in the tungsten and drawn away through wires by the electric generator.

Regulating the boiler temperature provides propellant feed control, while a solenoid valve between the boiler and the ionizer allows the propellant flow to be turned on or off rapidly.

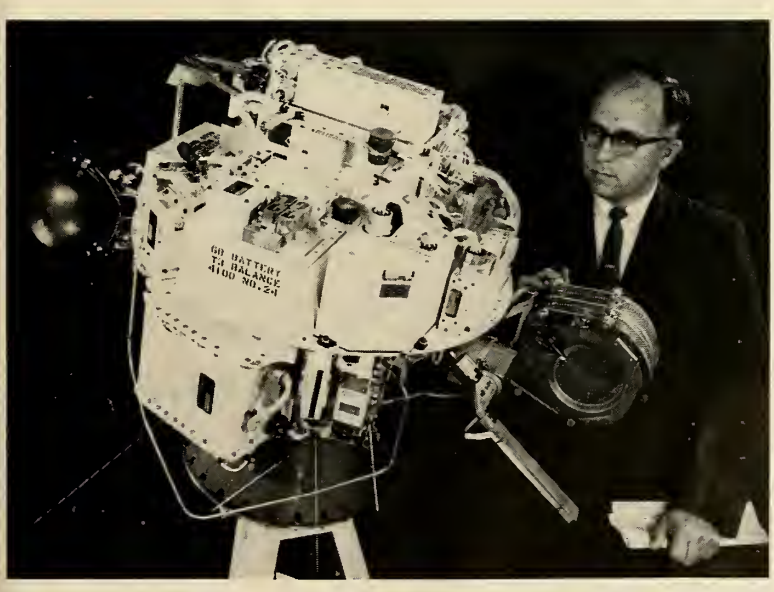
There are three electrodes—focus, accelerator and decelerator. The focus electrode is held at 4,500 volts above spacecraft potential, while the accelerator electrode is at 2,000 volts below spacecraft. The decelerator electrode is at spacecraft potential.

The cesium ions created at the ionizer are drawn away and accelerated by the difference in voltage. The potential difference of 4,500 volts between the decelerator and the ionizer controls the final ion jet velocity. The electrons drawn through the electric generator from the ionizer are emitted from a tantalum filament downstream of the decelerator to neutralize the beam.

Metals in a vacuum tend to release absorbed gas molecules from their surfaces. A metal engine in space would "outgas" for several minutes after liftoff. Such stray molecules around an electric engine could cause serious electrical arcing problems. To prevent this, the Hughes engine is mounted on the spacecraft in a cylindrical magnesium pod from which air is removed during launch operations. Launching the Hughes engine in a vacuum pod allows it to begin immediate operation in space with no outgassing problems.

The Lewis engine will not encounter any outgassing problem because it will be in space about 20 minutes before it begins operating.

In the Lewis Research Center engine, the mercury is vaporized in an electrically heated boiler and flows from there to the ionization chamber. In the chamber, electrons are emitted from a tantalum filament cathode or negative pole. These electrons move outward from the central cathode toward the cylindrical sheet anode that is 50 volts higher than the cathode. ■



SERT I SPACECRAFT is shown with Raymond J. Rulis, program manager, during checkout phase at NASA's Lewis Research Center in Cleveland.

SAC C&C System Tests Beginning

by Michael Getler

PARAMUS, N.J.—Major elements of the Strategic Air Command's 465L command and control system (SACCS), some seven years and $396 million in the making, are now being phased into operational testing at SAC headquarters at Offutt AFB, Omaha, Neb., and three other Air Force bases.

The entire system, linking all SAC bomber wings and ICBM commands with Offutt and the three numbered AF headquarters at March AFB, Calif., Westover AFB, Mass., and Barksdale AFB, La., is expected to be fully operational in mid-1965. Bulk of the hardware is now installed at all four locations. Major remaining installation work is in the software (programming and format) area.

While similar communications and display subsystems will be installed at all four locations, giving each the capability to serve as SAC headquarters, only Offutt and, to a lesser degree, March will have the major 465L high-speed data-processing hardware.

With the exception of sensor-type CMC systems, such as the BMEWS (474L) and SAGE (416L), 465L is the largest and most expensive of the Air Force L systems developed to date.

Contracted development began in September, 1958. Sources close to the project say the long span between concept and operational status, probably about three years longer than originally intended, was due in large part to the continuing redesign of 465L made necessary by the radical shift in U.S. strategic-force mix from 1958-1962.

Studies of interface of 465L with National Military Command System (NMCS) (M/R, March 30, p. 79) and the Air Force 473L headquarters system are now going on. Problems are mostly in computer format compatibility.

A prototype of 465L was unveiled publicly for the first time last week at International Telephone & Telegraph Corp.'s Data & Information Systems Div. test facility here. DISD is prime contractor for the program.

When fully operational, 465L—through the introduction of high-speed, high-storage-capacity on-and-off-line computers, high-speed printers, redundant communications channels, new store-and-forward switching networks, and a unique seven-color wall display system—is expected to greatly improve SAC's ability to rapidly compare its force performance with its battle plans. It also will add to SAC's ability to assess quickly its actual versus planned force readiness, to securely alert and commit its forces if necessary and to exercise its crews more effectively in peacetime.

As a system, 465L is subdivided into three major subsystems—data transmission, processing and display.

● **Data transmisson**—This is further subdivided into headquarters and remote site equipments. Remote Communications Centrals (RCC's) are located at SAC bomber, tanker and missile wing command posts and are basically input/output stations for gathering data on force, base, personnel and weather status. These stations can transmit and receive at up to 3,000 words per minute. Messages are typed in English but encrypted before transmission. The RCC's all have alternate communications channels.

All RCC's are now in the United States, including one at Elmendorf AFB, Alaska, and one at Ramey, AFB, Puerto Rico. Data from SAC's locally deployed forces are fed into 465L via other SAC communications nets. Bulk of the communications within 465L is handled by leased high-quality telephone lines.

Simplex-RCC's, essentially the same as the straight RCC's except that they are single-channel operations rather than duplexed, are located at all SAC missile bases.

"Subscriber "C" equipments are located at each remote missile launch control center with a rceceive-only capability.

The headquarters operations also have Electronic Data Local Communications Centrals (EDLCC's), which are basically the same as RCC's, serving as the input/output stations.

Each headquarters also has an Electronic Data Transmission Communication Center (EDTCC), which represents one of the key innovations of the 465L system. These EDTCC's are the store-and-forward switching networks using medium-size special-purpose digital computers. All messages, no matter where they originate or where they are directed, must pass through at least one of these centrals.

Unlike conventional switching systems, the EDTCC first enters an incoming message into its memory, compares it to a stored program of instructions and then forwards it. The computers each have a core memory of 32,768 32-bit words, a drum memory of 262,144 words and a main memory cycle time of eight microseconds. Each computer can accommodate up to 116 fully duplexed transmission lines.

Incoming messages are decoded, checked for address, parity and format. The system then transmits the re-coded message, holding it in storage until receipt is acknowledged. The system includes provisions for automatically selecting alternate routings, bypassing messages of lesser priority en route and querying senders of messages which appear to contain errors.

● **Data processing**—Three large-capacity computers, highly refined and transistorized versions of the same computer used in the SAGE Air Defense System, make up this portion. Two will be at Offutt and one at March. These use IBM 1401's as input/output devices, have a main memory capacity of 65,536 50-bit words, and access time of 2.5 microseconds, a disc memory storage of almost 13 million words, and an added 278,468-word drum storage.

● **Data display**—Data from the computer storage can be called up by SAC commanders via request panels at the headquarters. Some emergency-type information, usually unprogrammed events of importance—for example in-flight refueling delays—are automatically displayed.

Data may come out either as printer readout or in the form of a projected wall display. Printer speed is 1,000 72-character lines per minute.

For the large-scale, projected, multiple-screen display, data is first converted from digital to alpha-numeric form and presented on a character generator CRT. This image is then exposed onto a high-speed 70-mm film which can be processed either by wet or dry methods, the wet process cycle time being 10 seconds and the dry three seconds. The white light from a xenon projection lamp is split into three colors—red, green and blue. Through use of mirrors and additive processes, seven colors can be projected to keynote various data.

Average time between request and display of this projected data is reportedly 15 seconds. ■

AIAA Meeting Sets Future Format

Changes to be made before next July's San Francisco meeting may include longer exhibit hours, better handling of papers

THE SUCCESS of the first annual meeting of the American Institute of Aeronautics and Astronautics in Washington, D.C., was marred somewhat by low attendance. Nevertheless, AIAA officials assert that next year's meeting will, in general, follow the newly established format.

An expected registration of 5,000 proved to be double the actual total. The final count showed a registration of only 2,600 and a total attendance of about 4,100.

Even so, both conference officials and attendees reported general acceptance of the meeting format. Officials of next year's program already appear to be drawing up minor changes to answer criticisms of the recent gathering.

● **Conference critique**—The Institute, under its present schedule, will hold its second annual meeting next year at the Civic Center in San Francisco, July 26-29.

A variety of comments were collected by the MISSILES AND ROCKETS editorial team throughout the four-day meeting. They should serve as a critique and as food for thought for those handling next year's program.

In general, the conference was a success. Most of the survey papers did in fact relate the state of the art, current industry conditions, and near-future prospects for each of the aerospace industry's major technical disciplines. Some papers failed miserably, however, in the opinion of many industry observers. For example, they complained that one paper covering the *Saturn IB* vehicle program served only as an historical review. It was, they asserted, hardly a technical presentation but rather a reflection of past events—events already well known to the majority of conference registrants.

A paper by Harold Finger, head of the joint NASA-AEC nuclear propulsion office, represented the first major unclassified paper in the field. Cmdr. R. C. Duncan's paper on guidance and navigation was excellent as far as it went. He gave a fine breakdown, for example, of Dept. of Defense expenditures in the field; yet he neglected to include NASA, the agency which he now serves.

The synoptic papers—ten-minute deliveries designed to show only the recent technical advances in the various aerospace fields of interests—were generally well received. The biggest problem was that too many authors failed to appreciate the difficulty in preparing a short but informative talk. Too often, their introductions alone exceeded the total time limit.

Many felt that it was a mistake to separate synoptic papers from the survey papers covering the same field. Instead, they suggested, a technical session leading with a survey paper and then followed by a series of the ten-minute reports of technological advances in the same field would have produced a more complete report.

The complete absence of panel discussions was noted by many registrants. The consensus was that with the caliber of talent present at the conference, at least one or two open discussions by aerospace, technical and administrative leaders could and would have stirred up provocative and informative debate on any of a number of subjects.

● **Exhibit hall**—The lecture-demonstrations held daily in the three-room exhibit area of the Sheraton Park Hotel were well attended.

Exhibitors expressed pleasure with the professional quality of the viewers but were generally unhappy with the poor total attendance. They told M/R that the cost of exhibits and the per-square-foot charges for space will, in view of the less-than-anticipated number of attendees, make it difficult to persuade cost-conscious management to back exhibits again next year.

The decision by AIAA conference officials to deny the public admission to the exhibit area brought a mixed reaction from exhibitors. Most favored the decision, but some felt that at least a day or two should have been reserved for open attendance. This, they said, would help promote the industry and its program with those who in the end must pay the bills.

The most common complaint at the conference was over the closing of the exhibit hall at 5:00 p.m. Too many military and government workers in the Washington area were denied access to the exhibits by the early closing.

● **AIAA future plans**—AIAA officials already appear highly receptive to the reactions of members and conference participants. In response to a query by M/R one Institute spokesman said the following changes in next year's program are now being considered:

—Exhibit hall will be open to around 8:00 p.m. and lecture-demonstrations will run from 12:00-8:00.

—The technical paper format will be changed to bracket synoptic papers with survey papers covering the same topic.

—At least two evening panels will be held.

—The public will be admitted for at least a few days—or possibly for two days following the close of the meeting (exhibitors will be polled during the next few months to determine their reaction to the latter approach).

—Authors of future synoptic papers will be educated in the meaning and extent of such summaries—how they may be most effectively presented.

Some of the attendees, noting the wide breadth of the subjects covered in the sessions—from aircraft operations to astrodynamics—found this first annual meeting unfamiliar and confusing. They suggested, perhaps with tongue in cheek, that two annual meetings be held. One would encompass the missile and space papers, much like one of the AIAA predecessor societies did; and the other, the aeronautical papers. ■

Public Will Be Unwilling To Buy Costly Arms Inspection System

by Russell Hawkes

PROSPECTS FOR ADOPTION of a full-scale international arms control inspection system that might rival the present defense establishment in cost are virtually nil, reports an expert adviser to the government.

Dr. Albert R. Hibbs, head of the small arms-control study group set up at Jet Propulsion Laboratory to advise NASA and other government agencies on technological aspects of the subject, told MISSILES AND ROCKETS the all-out inspection system approach appears to be ruled out by psychological considerations. He explained that a costly and technically sophisticated arms control force could be justified to the U. S. taxpayer only by a very heavy atmosphere of international tension—and that this same atmosphere would make it impossible to write a politically acceptable treaty establishing the inspection force.

In view of these facts, Hibbs has concluded that any significant reduction in armaments will come as a result of tacit and informal understandings between the United States and the Soviet Union, with little recourse to conventional treaty-making machinery.

• **Like Antarctica?**—Hibbs said some students of the arms control problem are discussing the possibility of using the U. S.-Soviet Antarctica Treaty, which includes complete peremptory inspection rights for both parties, as a model for a Space Peace Treaty. This idea probably arises from the fact that both Antarctica and Space are difficult of access and hostile to habitation. Furthermore, the U. S. has successfully tested the peremptory inspection rights of the Antarctica Treaty.

A number of organizations in the U. S. are attempting theoretical approaches to the devising of arms control and disarmament systems. However, JPL's Hibbs said he has been "struck by the lack of reality in inspection systems strained to fit mathematical models of the problem." He said he is unable to imagine either the Soviet Union or the U. S. accepting them.

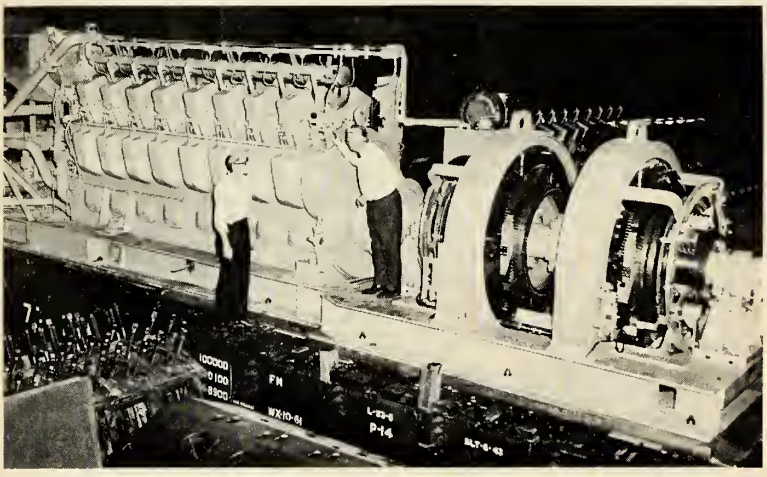
• **Other jobs**—One reason for the existence of the JPL study group is that NASA sees itself as the logical heir to the economic capacity of the defense-oriented segment of the aerospace industry if a downward trend in defense spending becomes well established. The group is supposed to supply NASA management with planning factors permitting an intelligent reaction to such a trend.

The group also examines the technological problems and possibilities offered by space in any arms-control operation. A critical problem in arms control inspection would be the discrimination between components manufactured for space vehicles and those manufactured for strategic missiles or spaceborne weapons. At the request of the Arms Control and Disarmament Agency, JPL has attempted to identify components and materials that are peculiar to missiles and not present in space vehicles. There is a similiar problem of discriminating between civil and military aircraft; a study has been made of the convertibility of transport aircraft to bombers.

To prevent the conversion of a peaceful space program into a military program, it has been suggested that the U. S. and Russia use a single international space launch site. Shipment of rocket materials toward any other destination would then be recognizable as a probable treaty violation.

Hibbs' JPL group has been studying whether or not Russia could conduct clandestine nuclear weapons tests on the other side of the Moon. It has concluded that while it is technically feasible, it is vastly easier to detect such tests than to conduct them.

Arms Control and Disarmament Agency has received an appropriation of about $7.5 million this year and the Dept. of Defense has received about twice as much for arms control work. Most technical work in the field is done by private contractors on a Request for Proposal basis. ■



Muscles for Apollo Transporters

DIESEL GENERATING unit being checked out at Alco Products, Inc., Auburn, N.Y., plant is one of four that will power two huge crawler-transporters at Kennedy Space Center. Unit includes 2,750-hp Alco engine, two GE generators.

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PROPERTY	TYPICAL VALUE
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Yield Point (MD)	1700 psi. at 3%
Stress at 5% Elongation (MD)	1900 psi.
Ultimate Elongation (MD)	300%
Tensile Modulus (MD)	70,000 psi.
Impact Strength	2 kg.-cm./mil
Folding Endurance (MIT)	4000 cycles
Tear Strength—propagating (Elmendorf)	125 gms./mil
Tear Strength—initial (Graves)	270 gms./mil
Tear Strength—initial (Graves)	600 lbs./in.
Bursting Strength (Mullen) (1 mil)	11 psi.
Density	2.15
Coefficient of Friction (Kinetic) (Film-to-Film)	.57
Refractive Index (Abbé)	1.341-1.347
Area Factor	12,886 sq. in./lb./mil

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Chemical Resistance: Resistant to practically all chemicals except fluorine at temperatures above 200°C., molten alkali metals and certain complex halogenated compounds.	
Moisture Absorption	Less than 0.01%
Weatherability	Inert Outdoors
Permeability	
Gas	cc./(100 sq. in.) (24 hrs.) (atm./mil)††
Carbon Dioxide	325
Hydrogen	2,340
Nitrogen	133
Oxygen	350
Vapors	gms./(100 sq. in.) (24 hrs./mil)††
Acetic Acid	0.02
Acetone	0.41
Benzene	0.12
Carbon Tetrachloride	0.05
Ethyl Alcohol	0.01
Hexane	0.19
Water	0.40

THERMAL

PROPERTY	TYPICAL VALUE
Melting Point (°F.)	500°-535°F.
(°C.)	260°-280°C.
Service Temperature—continuous	
(°F.)	–425° to +400°F.
(°C.)	–225° to +200°C.
Intermittent	
(°F.)	–425° to +525°F.
(°C.)	–255° to +275°C.
Coefficient of Linear Expansion	4.61 x 10^{-5} in./in./°F. at –100°F. 5.85 x 10^{-5} in./in./°F. at +160°F. 9.0 x 10^{-5} in./in./°F. at +212°F.
Coefficient of Thermal Conductivity	$1.35 \frac{(BTU)(in.)}{(ft.^2)(hr.)(°F.)}$ $4.65 \times 10^{-4} \frac{(cal.)(cm.)}{cm.^2)(sec.)(°C.)}$
Flammability	Non-flammable
Heat Sealability	Yes
Specific Heat	0.28 BTU/lb./°F.
Shrinkage (1 mil)	MD=0.7% stretch TD=2.2% shrinkage

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PROPERTY	TYPICAL VALUE
Dielectric Strength (1 mil)	6500 volts/mil at 23°C., 60 CPS
Dielectric Strength (20 mil)	1800 volts/mil at 23°C., 60 CPS
Dielectric Constant	2.1 at 20°C., 100 CPS – 100 MC
Dielectric Constant	2.13-2.04 at 1KC, –40° to 225°C.
Dissipation Factor	.0002-.0007 at 23°C., 100 CPS to 100 MC
Dissipation Factor	.0002 at 1KC, –40° to 225° C.
Dissipation Factor	.0005 at 100 CPS, –40° to 240° C.
Volume Resistivity	>10^{17} ohm-cm. (–40° to 240°C.)
Surface Resistivity	>10^{15} ohm/sq. (–40° to 240°C.)
**Surface Arc Resistance	>165 sec.

††Vapor permeabilities are determined at the partial pressure of the vapor at the temperature of the test.

**Samples melted in arc—did not track.

*Du Pont's registered trademark for its FEP fluorocarbon film.

possessing a combination found in any other plastic film

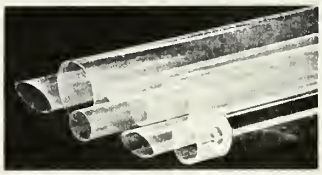
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PLAIN FILMS. Standard types come in ½, 1, 2, 5, 10 and 20 mil thicknesses. Roll widths from ½" to 48" in 1/16" increments. Also available in sheets. Special films for uses requiring high flex life under environmental extremes.



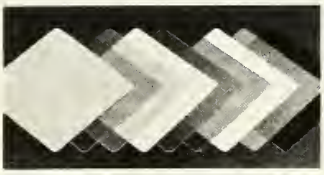
CEMENTABLE FILMS. Standard types with one side modified to accept conventional adhesives. Special film, with both sides cementable, is available in 1, 2, 5 and 10 mil thicknesses. All are transparent.



THIN WALL TUBING. Many sizes from 1" up to 6" I.D. are available. Heat shrinkable (at 210°F.) tubing is also available in 1.25" to 6" I.D. and .020" thick.



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COLORED FILM. Film can be supplied in a variety of colors for specific needs.



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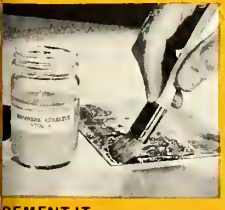
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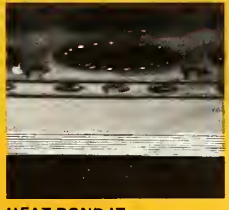
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It can be heat sealed by application of contact pressure at 300°C. to provide a plastic weld. Also it can be wrapped and fused into any complex shape for such uses as sleeves, thin wall hook-up wire insulation and many others.



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CEMENT IT...
Film is available with one or both surfaces treated to accept adhesives. "Teflon" FEP film can be laminated with adhesives to such substrates as steel, aluminum, copper, rubber, glass cloth and asbestos fabric.



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It can be directly heat bonded to various metal substrates, such as steel, aluminum and copper after proper metal conditioning treatment.

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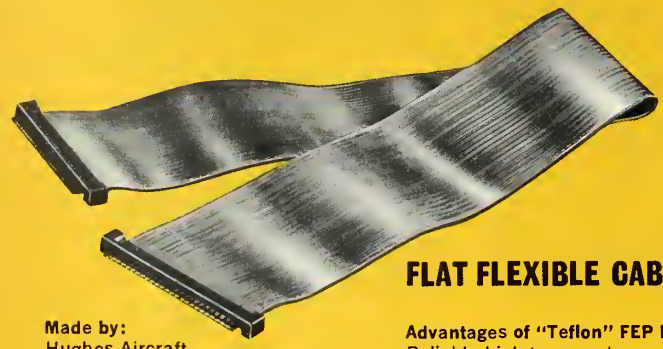
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Made by:
Arrowhead Products Division
Los Alamitos, California

Construction:
Flanged diaphragm of 60 mil "Teflon" FEP 19 inches in diameter

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Liquid oxygen compatibility; also, thermoforming avoids costly and elaborate molding and machining.



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Made by:
Hughes Aircraft
Culver City, California

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Advantages of "Teflon" FEP Film:
Reliable high temperature performance; low dielectric losses; high and uniform dielectric strength; non-flammable.



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Made by:
Swedlow, Inc.
Los Angeles, California

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Technical Countdown

MATERIALS

Aluminum Electroformed into Mirrors

Aluminum optical components are being electroformed by specialists at General Electric's Re-Entry Systems Dept., Philadelphia. Several highly accurate and reflective 3-to-8-in. paraboloidal mirrors, flats and corner mirrors have been made to date in the NASA-sponsored project. The mirror work marks the first time the entire structure has been electroformed from aluminum. Previously, aluminum had been electro-deposited on electroformed nickel structures. Dr. F. J. Schmidt, manager of Space Power Equipment Engineering says the mechanical properties of the formed mirrors are very close to those of 28 aluminum. Electroforming equipment is being developed for installation in Belleville, N.J., for the production of several-foot-diameter paraboloids. Two other GE techniques are involved. One is the spincasting of an epoxy paraboloid mold instead of grinding and the other is the elimination of electrodeposition stresses through a new stress control technique. The program may be a shot in the arm in the development of solar thermionic power systems.

NRC Broadens Superconductor Line

With the acquisition last week of Supercon of Houston, National Research Corp. will be marketing both major types of superconductors. The Norton subsidiary will absorb Supercon as a division that will concentrate on producing niobium zirconium superconducting wire. This material accounts for the major part of the present market for low field (up to 65 kilogauss) magnets. High field applications (beyond 100 kilogauss) of superconductivity such as fusion power and magnetohydrodynamics require materials such as niobium tin—which is an NRC production item. Dr. James Wong, founder of Supercon, will be general manager of the new NRC division.

AF Space Materials Handbook Revised

The Air Force Materials Laboratory at Wright-Patterson AFB, Ohio, is issuing a revised edition of the *Space Materials Handbook*. The 700-page publication was compiled and edited by Lockheed's Missile and Space Co. and contains expanded data on refractory metals such as tungsten and molybdenum as well as other spacecraft materials.

PROPULSION

Minuteman-Augmented Titan II?

Thiokol Chemical Corp. engineers and marketing experts are studying the effect of strapping M-55 *Minuteman* first stage motors on the *Titan II* launch vehicle. The study is being conducted in cooperation with the Martin Denver complex, prime contractors on the Air Force *Titan II* program. Two operational concepts have evolved so far. One would require the firing of four M-55 strap-on motors at launch with the *Titan II* ignition at altitude. The second covers a situation where only two M-55's would fire at launch together with the *Titan II* booster while the remaining two M-55 motors would ignite after burnout of the first two.

SPACE MEDICINE

Lack of Radiation Also a Problem

While the effects of ionizing radiations are being heavily studied, little has been done on the subject of the complete lack of such radiations. Observations by University of Bern (Switzerland) scientists for several years in the Simplon tunnel, which has been proven to be free of any traces of cosmic radation, show that such effects also exist. Artemia eggs showed only a 60-70% rate of offspring, Hordexum seeds became sterile after six months, and algae did not grow after a few weeks.

ELECTRONICS

X-15 To Collect IR Data

A solid-state detector device now under development at North American Aviation's Autonetics Division will be used on the *X-15* rocket plane to scan for high-altitude infrared radiation. The device will automatically search the earth and sky to focus infrared energy levels on the two detectors. The stored IR data will be available for prompt analysis by Autonetic engineers after each *X-15* flight. The program is funded by the Air Force Systems Command's Aeronautical Systems Division and is expected to contribute to joint NASA-Air Force space science programs.

Billion-Watt Laser Reported

A gigawatt-output pulsed laser has been developed, according to Maser Optics, Inc., capable of one pulse-per-second operation. Pulse width at these levels, the company said, is 30 nanoseconds. The system uses a Q-switching device, also developed by the firm, that employs a self-healing, liquid, passive complex contained in a single cell. The laser head uses 8-in. ruby rods and 8-in. flashlamps rated at 13,000 joules output each. Water cooling jackets are used to "optimize and stabilize output under repetitive operation."

H_2O_2 Reaction System Good for Ten Years

Spatial orientation and stabilization of the *Early Bird*, Communication Satellite Corp.'s first experimental satellite, will be achieved using a hydrogen peroxide reaction jet control system. Developed by Walter Kidde & Co. and originally intended for *Syncom II*, a newer version will be capable of at least a 10-year life. Twin systems will be developed by Kidde under a recently announced $369,000 subcontract from Hughes Aircraft Co., prime contractor for the *Early Bird*.

Isotope Power For Lunar Rover

A radio-isotope thermoelectric generator (RTG) for the *Surveyor* Lunar Roving Vehicle will be studied by RCA under an Atomic Energy Commission contract. The power pack will be required to produce 40 to 50 watts from a plutonium isotope yet weigh less than 30 lbs. and fit in a space 24 x 10 in. An operating life of one year is demanded. The generator power will be used to propel the vehicle over the lunar surface and operate its exploratory instruments. As part of the Phase I study, RCA will perform a safety analysis and a program plan preparation for Phases II, III, and IV.

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Resourceful Computer Application Keeps Hercules Plant on Schedule

Data-processing method has cut total costs by 25% on $100-million third-stage Minuteman program at Utah facility

by John F. Judge

MAGNA, UTAH—Imaginative use of computer-oriented data processing is providing accurate, fast and dependable management visibility into both current and projected problems in the production of *Minuteman* third-stage solid propulsion systems.

All management levels at the Hercules Powder Co.-Air Force Plant 81 use the same basic tool to keep abreast of demanding schedules in supplying third-stage *Minuteman* motors to the ICBM program.

The third-stage *Minuteman* manufacturing effort involves contracts exceeding $100 million, with half going to subcontractor-supplied material and the rest meeting labor and overhead costs. In addition, there is the flexibility demand in meeting changing schedules, reaction to fiscal funding—which means continuous pressure to keep costs down —an extremely high quality level and the need to respond with solid, provable facts on performance.

Hercules management realized from the construction start at Air Force Plant 81 that proper evaluation and control would have to involve the development of an electronic status reporting and scheduling system.

The success of the melding of management techniques with data processing in production control is evident from the results.

Since the inception of the production contract on the missile:

—Total costs have dropped about 25% and are still going down.

—Labor costs have been cut 40% and more are in the offing.

—Delivery schedule problems have been eliminated.

—Ability to identify, interpret and respond to production problems quickly and effectively has been demonstrated.

All of this was accomplished while meeting the *Minuteman* program objectives with a direct work force varying from a peak of 1,200 down to 600 people. It involved the start-up of a new facility with new people—and a hiring and training rate of 200 per month in the beginning.

A card is assigned each motor and, as the motor travels to each of the 13 stations, reporting is done as to its current status. Since each motor has about a 60-day production cycle, there are obviously many motors in the facility at any one time. Management can tell at a glance the status of each unit, and a query to the IBM system will produce a status report on any motor in a moment.

The tool itself is a combination of IBM data-handling machines and computers. The production and cost-control system built around this base by Hercules engineers is keyed to actual manufacturing steps in the flow of motors through the Bacchus, Utah, facility.

● **Reliability goal achieved**—Many of the programs are based on the input production aids electronically transmitted from the production complexes. This information governs the reliability of the system. The present transmission reliability at Plant 81 is approximately 98%.

This rate of efficiency is exactly the target figure established by Hercules planners and provides output that can be used with confidence.

The system proved itself when the plant phased out of a three-shift operation to two shifts. The transition was accomplished after running production-simulation studies into the computers to derive flow rates and approaches to achieving these rates. The switch from three to two shifts was done on an incremental basis across three general production areas and 25 different production activities. It went without a hitch.

The Hercules motor is a glass-wound reinforced plastic unit loaded with double-base propellant. The glass cases come from the Hercules Clearfield, Utah, and Rocky Hill, N. J., facilities to the incoming materials inspection area at Plant 81.

The lined cases are inspected and some insulation is added. The pressure vessels are coated internally with a bonding agent. Insulation is applied to the external areas and powder is embedded in the inner surfaces.

The cases are loaded with the base grain powder after insertion of core molds and various handling devices held under vacuum to remove moisture, and then impregnated with casting solvent. The solvent contains nitroglycerine, plasticizers and stabilizers.

The motor is then cured at elevated temperatures, cooled, machined, X-rayed. Final hardware such as nozzles, igniters, safe/arm devices and other required items are then added.

If all quality assurance steps and specifications have been met, the Air Force then checks the motor over and accepts delivery. The computer-oriented production control system is linked to all key operations through the processing cycle.

● **Machine breakdown**—The equipment in the system consists of an IBM 1410 data processing system with a 1301 disc storage and a 1014 remote inquiry unit. Each of the 13 key production locations in the process buildings has an IBM 1001 data transmission system terminal. The 1001 input devices are connected to the data-processing center through phone lines.

The 1001 units are linked to a keypunch card printer at the data-processing center. These cards provide the input to the IBM 1410 computer system without manual effort—providing real time in the system.

The IBM 1014 remote inquiry unit is installed at the production control center located at the processing plant itself. It is connected to the data-processing equipment in Hercules Plant 1, two miles away, via cable.

The entire system is updated every two hours during the work shifts. Deviations from the schedule are noted and the details are transmitted via teletype to the production control center for on-the-spot correction. Once the correction is made, notification is returned to the data-processing center over the same teletype circuit and fed into the system.

● **Workpaper generation**—This data-collection system provides all levels of management in Plant 81 with the following various means of controlling production.

Production activity shift report—An output designed as a tool for production supervision and prepared at the end of each eight-hour shift. It shows all activity by complex during the previous shift.

Only motors changing status during this period appear on this report. Information included covers motor number, task nomenclature, complete manufacturing and inspection record, number of the affected operation—including area, complex, operation and task numbers, scheduled flow time of the task, transaction code on which the task was entered and the day and time of the transmission. Descriptions of any stoppage are included.

The incoming and outgoing production foremen use this report as a "talk" paper to insure a smooth transition and coordinated production effort between shifts. It actually frees the foreman from paperwork and allows him to function as a supervisor.

Daily motor status report—This is one of the most informative outputs of the system. The report shows by motor the task being performed on each motor, detailing the time the task was started, the complete time for each task, stoppage condition or no, rate of progress in hours against an established standard treatment flow for the 24-hour reporting period and the scheduled and projected completion dates, with the resultant variation in days for each motor, based on its current status.

The report also contains a remarks section listing all by-passed tasks, production gain or loss in hours on all tasks completed within the past 24 hours and the number of hours and descriptions for any stoppages started and ended within the period.

Projected shop schedule by motor—Produced weekly as a tool for planning and scheduling, this report is the result of computer programs simulating a schedule and rescheduling all motors through all remaining complexes. The 1410 program finds the current motor status in the 1301 motor status file and schedules the motor into each remaining complex based on shop capacity, flow time of each task and shop load. The planning and scheduling people can then determine when each motor will be available in the complex.

A weekly program analysis is published to give management a more detailed status of the entire program. Graphic presentation is used and each chart is accompanied by an analysis stating the problem, elaborating on the status and pointing to any impact on the schedule.

A line-position chart shows the location of each motor in the production line related to the contract schedule. A "Line of Balance" chart shows the slippage conditions based on lead time and availability of the component at the Bacchus Works.

A data log furnishes historical information on each motor from which a motor history log is produced each month to reflect all activity on each motor during the month.

Hercules experts have broken the total operation into tasks and operating codes to provide management with additional analysis routes. The operating codes are further segmented into the type of work accomplished—production effort, rework and clean-up.

A monthly report is prepared with this information, complete with graphs. A glance at this presentation will show the relationship of production effort to clean-up and rework. It also shows the average number of wage hours expanded per case processed, the equivalent units processed each month and the cumulative average at the point in time.

● **Operating terminology**—The equivalent unit (EU) is a device used throughout the reporting system and is based on the master manufacturing plan. It is determined by the number of flow days and manhours required to manufacture a motor.

The production of a motor is broken into various sequences and the sum of these equals one equivalent unit. Fractional equivalent units are calculated by computing the percent of manhours required to complete one of the 27 tasks.

A REPRESENTATIVE daily production status report such as the one below is distributed every working day and covers the current tasks being performed on all motors in the plant. The third through seventh columns all relate to current task status, the eighth and ninth columns cover task-completed information. The remainder cover motor-completed information while the last two columns explain the Col. No. 5 code and indicate under remarks the by-passed tasks, stoppage losses and other pertinent information. Motor and case numbers appear in the first column, next to the building location.

DAILY PRODUCTION RATE - STATUS REPORT — PLANT 81 — DATE 2283 07 APR 1964

MOTOR NO	LOC	TASK STATUS OPER	NOMENCLATURE	TC	DATE	TIME	TASK COMPLETE DATE	TIME	RATE OF PROD	MOTOR COMPLETE SCHED	VAR	PROJ	REMARKS BY-PASSED TASKS, STOPPAGE LOSS, ETC.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
880060	10-A	0924	MEASUREMENTS	12	04-06	08 00	04-06	02 39	76/24	04-10	00	04-10	CONCURRENT	PROD PRIOR 78 HOURS PROD GAIN 0822 76 PROD LOSS 0923 26 (15 HRS 7 Apr
45B 8800074	10-B	0822 0924 0923	NOZ + TT INST MEASUREMENTS APPLY RTV	28 12 12	04-07 04-07 04-07	02 00 13 04 13 49	04-08 04-06 04-08	17 03 09 04 13 49	09/24	04-10	00	04-10	PROD PRIOR CONCURRENT CONCURRENT	FACIL OVLD 11 HOURS (ROCKET ASS PAST SCHED COMP TASK 0924
459 HP00222	10-B	0822 0924	NOZ + TT INST MEASUREMENTS	12 12	04-07 04-07	15 51 13 04	04-09 04-07	04 57 0425	07/24	04-14	01	04-13	CONCURRENT CONCURRENT	FACIL OVLD 11 HOURS (ROCKET ASS PROD PRIOR 14 HOURS BY-PASSED 0923 PAST SCHED COMP TASK 0924
4T0 [illegible]0075	5-A	0620	SURGE STORAGE	10	03-31	15 18	04-03	15 18	00/24	04-21	-01	04-22	IN SEQUENC	PAST SCHED COMP TASK 06
		0822 [illegible]23	NOZ + TT INST APPLY RTV MEASUREMENTS	12 12 28	04-[illegible]	[illegible]	04-08	12 34 11 02	37/24	04-14	04	04-08	CONCURRENT	

Several motors may be processed in these tasks at any given time. The sum of all fractional equivalent units manufactured during any period of time is used as the basis in determining the amount of production during a specified period.

A weekly EU production report is used by the production superintendent in his comparison of the actual with the forecast. A monthly EU report is used by the plant superintendent and the plant manager as an indicator of the status of the entire production process.

Based on past history—and this is immediately available on demand from the data-collection system—it is possible to project into the future the direct labor required to manufacture any given number of units.

The farther the projection into the future, the less accurate are the results. This is because of the nature of weapons systems production.

Analysis of such historical data indicates that errors of less than 5% have been experienced in long-term forecasting using an improvement curve, while short-time forecasting decreases the error to less than 1%.

With almost two years of development, operation and modification experience under their belts, Hercules Plant 81 executives—with the advice of their computations department—are continually finding new uses for the basic data-collection and reporting system. Besides all the various production-oriented reporting functions, it is possible to query the system with regard to any motor in the program through the remote inquiry unit and receive—within seconds—a completely typed-out description of motor status, which is never more than two hours old.

● **Cost breakouts**—The data-collection complex is used extensively by the cost analysts in the *Minuteman* motor program. The basic EU forecast, derived from the master manufacturing schedule, is used to budget labor and material dollars by the month for the entire program.

It is also employed to determine overhead rates for future years. When the actual data is plotted against these forecasts, the program manager can tell at a glance—at any given time—the exact financial and production status of the entire program.

The graphical presentations derived from the system and collated with other pertinent information is bundled into a simple production summary. This summary, updated daily, provides top management with both the actual day-to-day operations flow and the projections 30 days into the future. The report matches actual production with forecasts and indicates problem areas long before they occur in the processing buildings.

Thus management decision response tends to build up lead times on a cumulative basis. This real-time lead time is highly effective when the unforeseen happens—such as a random failure in a routine quality assurance test. The buffer zone available varies from day to day but the response inherent in the data system used as a tool gives the program manager decision flexibility.

For example, a number of alternate changes in the entire production flow can be set up while the exact nature of the bottleneck is being determined. It also allows the manager to tag each with time priorities. The end effect is to eliminate impact on final product scheduling to the customer.

● **Future uses**—The latest development growing out of the data-collection tool is called a mechanized manufacturing and inspection record (M&IR). This item is sold with the motor and contains logged information on every step in the manufacturing process.

The mechanized method now in development at Plant 81 will initially serve two purposes—and both have a substantial cost-reduction potential.

First, since the implementation date of June 1, all M&IR pages have been printed by the computer and based on motor line position as indicated by the daily report. These pages are ready for line use as received from the computer.

Second, assignment of activities for all changes in design, drawings and the like will be performed by the computer, thus providing complete computer control of all manufacturing documents.

A history will be retained for each motor produced at Plant 81. A listing of each significant document will be available on recall. These documents include general operating procedure, unit operating procedure, quality assurance and other similar data.

This is useful in handling questions regarding which motor or block of motors was built according to a particular document. The history can be sorted by motor number or by all motors built in accordance with a specific document number.

The amount of machine time required to print all the pages necessary for a standard M&IR book will take about seven minutes. This paper load can be two to three inches thick.

The generation of M&IR pages is simple and rapid. Key jobs in the master job files initiate specific blocks of M&IR sequences as well as applicable motor job cards. The start of key jobs generates the succeeding M&IR packet and motor job cards automatically.

Other reporting innovations are under study and may soon join the present group of systems. Cost information and utilization approaches are part of these development concepts. ■

Management Tool Explained

For security reasons, the information appearing on the summary at right and the daily production status report on the preceding page do not reflect actual Minuteman production. The data does tie together, however, for purposes of illustrating the management tool.

The summary chart on the right gives the plant manager the entire picture at a glance. This chart is updated daily but reflects a two-month period. In this case the chart shows the production flow as it existed at midnight Feb. 19. Since there was no working shift between midnight and the first morning shift Feb. 20, the updating function reports no change.

In the battery of charts detailing the motor and case status, the straight lines are projected schedules while the other line in each case represents the actual schedule. The shipments chart shows both lines merged, since motors delivered are exactly on schedule.

One of the main advantages of the computer is in building forecasts based on actual day-to-day production events. This projection for the month of March is shown next to the February projection. The February chart, complete to the 19th day with actual production rate data, is itself a result of the previous month's projection.

A glance at this chart combination shows management the high and low points in task units projected into the next month. Based on this general indication, the next step is to go into the system by tasks to pinpoint any possible delay and then initiate procedures that will preclude it.

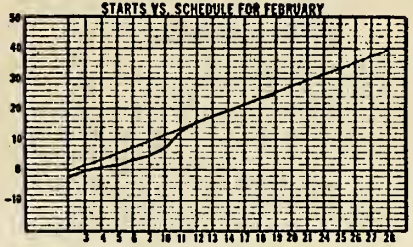
The information appearing in this concise summary is derived in turn from the various daily, weekly and monthly reports generated by the Hercules application of data from the collecting system. In each specific area as shown on this summary, there exists a completely detailed breakdown on a much broader basis.

The manager is alerted to coming events by this summary, and, depending on where the events are occurring, he can go into the detailed reports in that area within minutes.

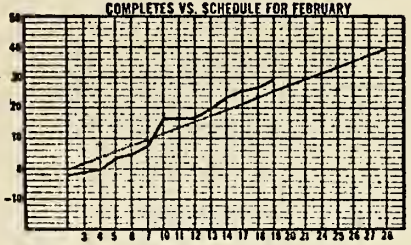
The summary is actually the top of the data-collection system "iceberg," and effectively tells top management where to concentrate its effort daily.

MOTORS

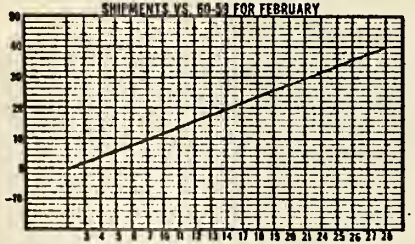
STARTS VS. SCHEDULE FOR FEBRUARY



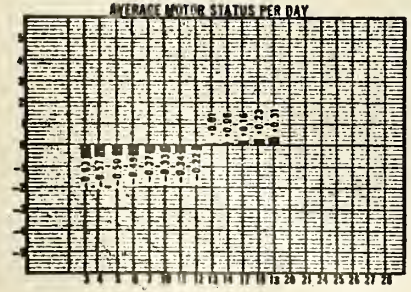
COMPLETES VS. SCHEDULE FOR FEBRUARY



SHIPMENTS VS. 60-59 FOR FEBRUARY

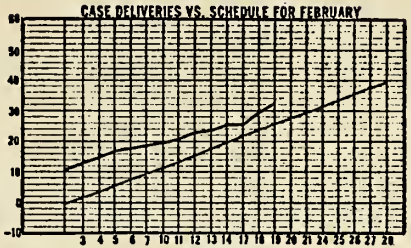


AVERAGE MOTOR STATUS PER DAY

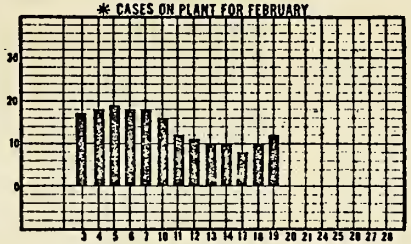


CASES

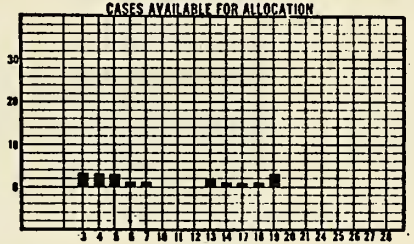
CASE DELIVERIES VS. SCHEDULE FOR FEBRUARY



* CASES ON PLANT FOR FEBRUARY



CASES AVAILABLE FOR ALLOCATION



UPDATED 0900 HRS. 20 FEBRUARY

CHART CURRENT AS OF 2400 HRS. 19 FEBRUARY

NO. OF MOTORS STOPPED	7
PERCENT OF MOTORS STOPPED	6.6
PERCENT EFFICIENCY	98
NUMBER OF UNITS IN PROCESS (THROUGH TASK 25)	105

* INCLUDES THE FOLLOWING CASES

SCHEDULED ——

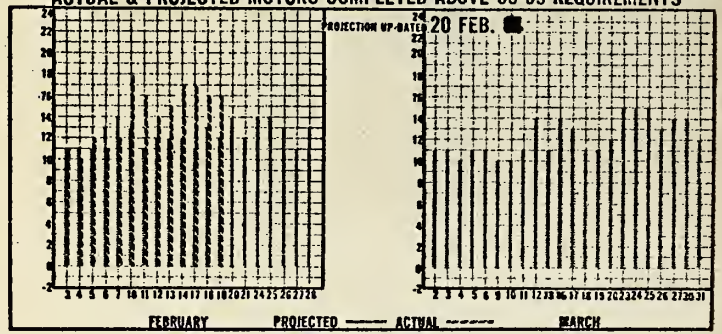
ACTUAL ——

MOTOR STATUS

DATES	STARTS VS. SCHEDULE	COMPLETES VS. SCHEDULE	SHIPMENTS VS. 60-59	CASE DELIVERIES VS. SCHEDULE	CASES ON PLANT	CASES AVAILABLE FOR ALLOCATION
13 FEB.	0	+2	0	+6	15	2
14 FEB.	0	+4	0	+8	10	1
17 FEB.	0	+4	0	+4	9	1
18 FEB.	0	+3	0	+8	10	1
19 FEB	-1	+6	0	+7	12*	3

* INCLUDES 7 +13 CASES

ACTUAL & PROJECTED MOTORS COMPLETED ABOVE 60-59 REQUIREMENTS



QA FIRING DATE

QA NUMBER	MOTOR NUMBER	EST. FIRING DATE	ACTUAL FIRING	QA NUMBER	MOTOR NUMBER	EST. FIRING DATE	ACTUAL FIRING
QA(SPS)	2A1		01-31-63	QA 23	4C2		02-07-64
QA 1	2A0		03-06-63	QA 24	4C1	03-02-64	
QA 2	292		03-09-63	QA 25		03-06-64 *	
QA 3	293		04-02-63	QA 26			
QA 4	2C5		04-16-63	QA 27			
QA 5	2C3		04-17-63	QA 29			
QA 6	296		05-15-63	QA 29			
QA 7	2F3		07-12-63	QA 30			
QA 8	298		08-06-63 (AEDC)	QA 31			
QA 9	2M1		08-10-63 (AEDC)	QA 32			
QA 10	2P5		08-09-63	QA 33			
QA 11	286		08-29-63	QA 34			
QA 12	2S3		09-04-63	QA 35			
QA 13	2T0		09-16-63	QA 36			
QA 14	2W6		10-10-63	QA 37			
QA 15	3C3		10-02-63	QA 38			
QA 16	2Y0		10-31-63	QA 39			
QA 17	300		11-06-63	QA 40			
QA 18	2Y7		11-29-63	QA 41			
QA 19	3C4		12-04-63	QA 42			
QA 20	307		12-20-63	QA 43			
QA 21	3P0		01-02-64	QA 44			
QA 22	309		01-17-64	QA 45			

* BASED ON DROP DEAD LOT COMPLETION SCHEDULE -12 MANUFACTURING DAYS

A-G Finds Filament-Wound Minuteman Cases Would Be Lighter Than Expected

Four second-stage glass fiber cases built and hydrotested to destruction in AF-sponsored work; rigidity exceeds expectations

by Willard E. Wilks

AZUSA, CALIF.—An Air Force program to establish optimum design parameters for filament-wound solid rocket motor cases indicates that a case made to meet actual flight loads would be lighter than was formerly considered necessary.

This is the report of Aerojet-General Corp. following recent completion of the program, in which the firm fabricated and tested four filament-wound cases identical in size and shape with the metal second-stage *Minuteman* motors. All were hydrotested to destruction following preliminary proof-tests. The program was conducted by Aerojet's Structural Materials division, Von Karman Center, for the Materials Application Division, AF Materials Laboratory.

Design of the four cases (44.3 in. in diameter and 127 in. long) was based on the pressure requirements of titanium *Minuteman* second-stage cases now in production. Design burst pressure was set at 734 psi, 25% above the proof pressure of the metal cases.

Aerojet spokesmen emphasize that the cases were not flightweight, but were designed for pressure requirements only.

Preliminary specifications (wall thickness in heads and cylinders) for the filament-wound cases were set on the basis of tests determining the strength of the glass fiber used.

The first two cases, using a standard Type E filament, were fabricated and tested within 11 months after the start of the program. They were 7.5% lighter





than a comparable titanium case, yet demonstrated burst-pressure levels above the design maximum of the metal cases.

The third case was made from a newer type AF-994 fiberglass recently developed for Air Force filament-winding programs. Its higher tensile strength (about 20% more than "E" glass) permits reduced wall thicknesses, making the finished case 19% lighter than a titanium *Minuteman* second stage.

The fourth case, also fabricated from AF-994 glass, was made identical to the third, which served as a control for evaluating results of the structural load testing.

In the hydrotests, the first case burst at 855 psi, the second at 730 psi, the third at 728 psi, and the fourth at 696 psi. Even 5% below the design burst pressure is considered very good, well above the operating proof pressure of the titanium case. The first case was fabricated heavy to establish the basic design criteria.

Design thickness composite for the first case was case head, 0.068 in.; hoop, 0.094 in., with total cylinder wall of 0.162 in. Second case head dimension was 0.051 in., hoop, 0.082 in., with total cylinder wall of 0.133. In the other two cases, heads were 0.042 in.; hoops, 0.066 in., with total cylinder walls of 0.108 in.

Sidney Litvak, Air Force head of the program at Wright-Patterson AFB, pointed out that since the four chambers were designed to the second-stage *Minuteman* pressure requirements only, additional longitudinal filaments would be required to meet the stiffness needed for flight loading.

● **Loading crucial**—The structural loading tests on the fourth case, which climaxed the program, had three objectives: (1) to determine the effect of bending and compressive loads on the ultimate strength of the case, (2) to measure experimentally its compressive modulus, (3) to measure flexural and compressive rigidities of the *Minuteman*-size glass case more realistically than had been possible previously.

For the structural trials, the fourth case was mounted in a hydrotest stand and axial and bending loads were applied through a ring attached to the forward skirt of the chamber. Instrumentation consisted of linear motion transducers and strain gages, recording a total of 96 channels of information. The case was put through a five-step program:

—Hydrostatic proof test—pressure applied at a strain rate of 1% per minute and held 90 secs, at the specified level.

—Axial compression—loaded to 60% of the total force calculated axial buckling load and 30% of the calculated critical bending moment and holding for 1 min.

—Bending load—60% of the calculated critical bending moment also held 1 min. The test was repeated at a strain rate of 5% per minute (five times the rate in the other tests) to the maximum load, with no dwell time.

—Hydroburst test—pressurizing the case at a strain rate of 1% per minute to final burst, which occurred within 5% of calculated maximum pressure.

● **5% dividend**—Engineers concluded following the test that the actual flexural rigidity of a filament-wound second stage would be 5% greater than the calculated values established before the test program, indicating a case to meet flight loads could be lighter than previously thought.

The fourth case was designed for a composite rigidity of 4.62×10^7-lb. in.^{2} Actual rigidity was 4.95×10^7-lb. in.^{2} Actual flexural rigidity for this case was 1.62×10^{10}-lb. in.^{2}

Weight of the fourth case was 260.61 lbs. A titanium case of equal size would weigh 321 lbs. and would have a stiffness of 5.15×10^{10}-lb. in.^{2} A glass case built for flight loads would weigh more than 260.61 lbs., however, since longitudinal filaments would have to be added to add the stiffness required. Spokesmen declined to attempt an estimate of how much more the glass case would weigh without additional research.

● **Payoffs**—Air Force reports that data from the program already has provided an immediate benefit, contributing to the upgrading of performance parameters for filament-wound cases in other programs.

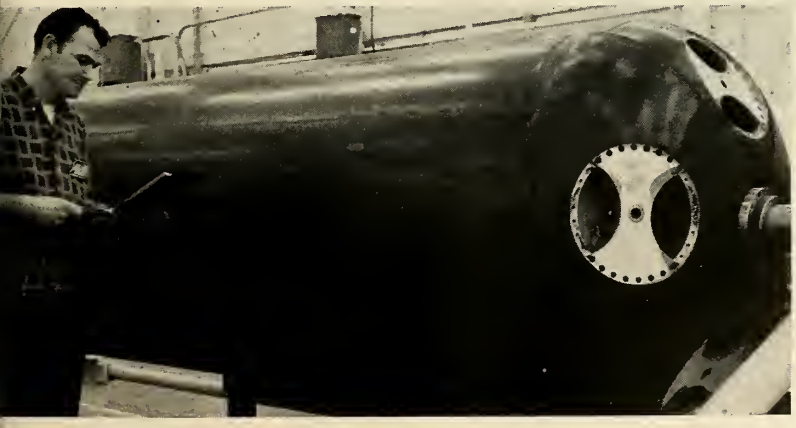
W. R. Rozance, manager of Aerojet's Structural Materials division, declared the demonstration "permits designers to consider filament-wound case construction during preliminary design stages when modifications to dimensions may easily result in meeting stiffness requirements and at the same time achieve weight savings."

Rozance said the program showed sufficient structural capability in a filament-wound case to justify investigating the possibilities of such cases for new generations of missiles such as advanced *Minuteman* or the *MMRBM*. New high-modulus glass filaments being developed, together with the savings involved, will give rocket engineers additional information in order that the positive characteristics of filament-wound cases can be clearly analyzed in the initial design stages.

Aerojet has been selected to design and fabricate 260-in. filament-wound cases, and the division currently is working on a program to build one of these chambers.

Aerojet has built and successfully subjected to hydroburst test a subscale 260-in. case 54 in. in diameter and 11 ft. in length.

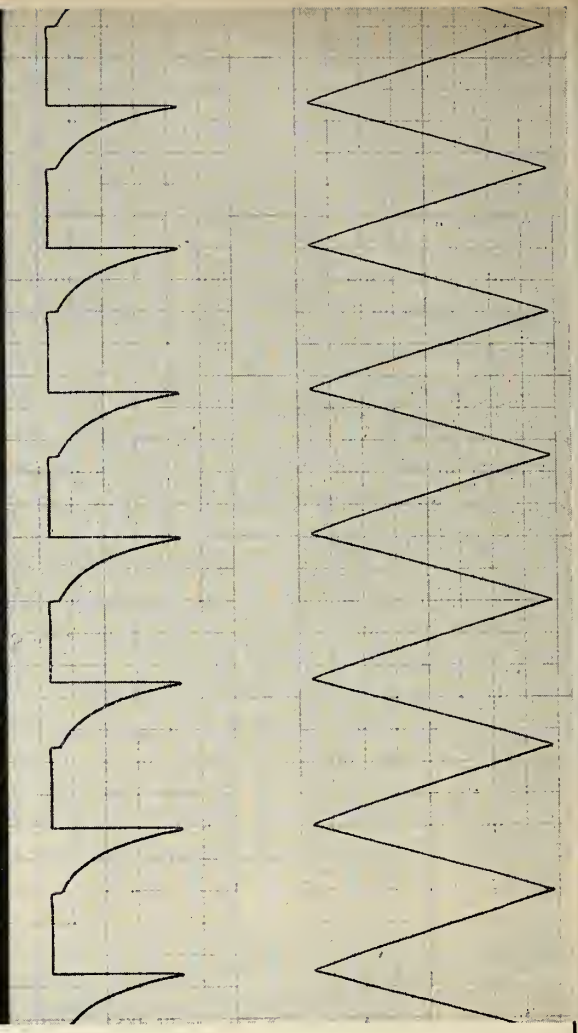
For fabrication of the full-scale 260-in. glass case, a filament-winding machine is under construction at Todd Shipyard, San Pedro, Calif., where the big case will be fabricated. ■



FAR LEFT: Hydrotest to destruction of experimental Minuteman-size filament-wound case climaxes in splash of glass strands and water. Aerojet designed cases to burst at 25% higher proof-pressure level than that required for comparable steel or titanium cases. LEFT: Hoop wrapping of Minuteman-size filament-wound begins as skirts are fitted at ends. Wrap is made by nine individually tension-controlled strands of glass filament paying off the spool table (left) while case revolves and table travels vertically. Longitudinal filaments already have been wound by pay-off arm (upper right), which swings around revolving case in vertical circle. Aluminum skirts on cases in Air Force-Aerojet research program were for case handling only. Production cases would have glass resin composite skirts to carry structural loads. ABOVE: Inspector at Aerojet's Structural Materials Div. makes final check of lined mandrel for 44-in.-dia. filament-wound motor case before vacuum bagging for liner cure.



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Specifications:

Number of Channels	1-8 standard; to 24 special
Sensitivity	With preamp 1μv/mm to 5v/mm Without preamp 1mv/mm to 5v/mm
Frequency Response	DC to 150 cps
Phase Delay	2.5 ms ± 0.05 ms, 0-120 cps
Linearity	0.1% (full scale) for DC: or AC within maximum amplitude envelope
Drift	(shorted input) With preamp 1μv/hr at max. gain Without preamp <0.05mm/hr
Recording Amplitude	Full chart channel width from DC-40 cps with progressive reduction to 5mm at 150 cps
Input Impedance	With preamp 2 megohms without preamp 1 megohm
Warm-up Time	Instantaneous
Nominal Cost/Channel	With preamp $1,250 Without preamp $850

Beckman® INSTRUMENTS, INC.

OFFNER DIVISION

Schiller Park, Illinois

International Subsidiaries: Geneva, Switzerland; Munich, Germany; Glenrothes, Scotland

063-650

Circle No. 8 on Subscriber Service Card

The Industry Week

New Activities

The Council of Defense and Space Industry Associations (CODSIA) has been created with headquarters in Washington, D.C., under the sponsorship of the Aerospace Industries Association, the National Security Industrial Association and the Electronic Industries Association. Purpose of the voluntary, unincorporated, non-profit council is to provide "a new sounding board of industrial opinion . . . for government officials." CODSIA's charter specifically states that the association will not engage in lobbying activities nor represent the interests of individual companies. . . . *Tamar Electronics Industries, Inc., Los Angeles, has formed a new division for research, development and manufacturing in the field of dynamic measurement and control. The new organization will be called the American-Wiancko Instrumentation Div. and will combine the capabilities of the American Gyro and Wiancko Engineering Divisions of the corporation.*

Mergers and Acquisitions

Electro-Optical Systems, Inc., Pasadena, Calif., has acquired the fixed assets, management and part of the technical staff of Correlated Data Systems Corp. of Glendale, Calif. CDS develops digital-to-analog converters, correlation detection and bit synchronization techniques and produces data acquisition and checkout equipment for use in space vehicles and missile systems. It will be operated as the Data Systems Program Activity of EOS's Program Management and Systems Engineering organization. . . . *Electronic Specialty Co., Los Angeles, has acquired the assets of Data Recovery Systems, Inc., of Culver City, Calif. DR manufactures and markets specialized magnetic tape recorders for military applications.* . . . Avnet Electronics Corp. New York City, has completed preliminary arrangements to acquire the assets of Valley Forge Products, Inc., an automotive replacement parts manufacturer. Move is described by Avnet as one "away from defense electronics and a resumption of an aggressive acquisition program." . . . *National Research Corp., a subsidiary of the Norton Co. has acquired Supercon of Houston, a producer of niobium zirconium wire and other superconductors for cryogenic applications.*

Industry Facilities

Associated Testing Laboratories, Inc., Wayne, N.J., has added $500,000 worth of new facilities to meet the demands of its major systems testing projects connected with the *Gemini, Ranger* and *Apollo* programs. One of the primary additions made by ATL was the purchase of a space simulation chamber capable of simulating altitudes up to 1,500,000 ft. ($1x10^{-9}$ torr) and producing temperatures in the range of —300° to 500°F. For large assembly testing, ATL installed a 10,000-force-lb. random vibration system, a 6-in. Hyge shock tester and a 2,500-lb. low frequency vibrator. . . . *The Garrett Corp.'s Airsupply Div. has announced plans for a new headquarters building in Santa Monica, Calif. Construction on the 14,450-sq.-ft. structure is to begin this month. Airsupply provides nationwide engineering/sales representation for firms in the defense, aerospace and specialized commercial industries.* . . . The Hallicrafters Co. has opened a new 83,000-sq.-ft. Research and Production Center for its Manson Laboratories Div. in Wilton, Conn. The facility houses all of the division's engineering, research, sales administration and production personnel. Total cost of the facility is estimated at $1,700,000. . . . *Allied Chemical Corp. is renovating the old New York Times building at Times Square, New York City, to house the firm's exhibit and marketing center and headquarters of its fibers Div. A 10-story vertical display well on the north wall of the building will contain lighted exhibits visible to upper Times Square.* . . . The 1st Strategic Div. of the Strategic Air Command has assumed real estate management of the former Naval Missile Facility at Point Arguello, Calif. The annexation adds some 19,000 acres to Vandenberg Air Force Base, which is adjacent to the facility. By July 1, 1965, the Air Force's Western Test Range is to assume responsibility for operating and maintaining the Pacific sector of the National Range. . . . *Rogers Corp., Rogers, Conn., producer of molded circuits, has completed a new 35,000-sq.-ft. plant. The new facility is expected to triple production capacity.* . . . Volumetrics, a manufacturer of precision pneumatic pressure control and calibration systems, has moved to new quarters in Inglewood, Calif. Move was designed to provide space for expanded sales, laboratory and production activities.

International

Hawker Siddeley Dynamics Ltd. of Great Britain has reached a licensing agreement with Hamilton Standard Div. of United Aircraft allowing Hawker Siddeley to sell Hamilton Standard's electron beam machine in the British Commonwealth (with the exception of Canada) Norway, Sweden and the Union of South Africa. Hamilton Standard owns the world-wide patents on the electron beam process, originally developed by the Carl Zeiss Foundation of West Germany.

ARC Files New Prospectus

Atlantic Research Corp., Alexandria, Va., rocket firm, has filed a new prospectus covering 179,000 shares of outstanding common stock that the Securities and Exchange Commission has refused ARC permission to register. The new report also covers 421,000 shares owned by ARC chairman Arch C. Scurlock, which are pledged to secure loans made to him by banks and brokers. The SEC has called a prospectus filed by the company last December a "mockery of the truth." ARC countered by saying the SEC's conclusions were "erroneous."

AWARDS

AIR FORCE

$11,300,000—**ITT Federal Laboratories,** Nutley, N.J., for electronics and radar components.

$7,713,833—**Vitro Corp., Vitro Services Div.,** New York City, for management and operation of Air Proving Ground Center/Eglin Gulf Test Range areas in Florida.

$6,410,512—**American Air Filter Co.,** St. Louis, for environmental control systems.

$4,800,000—**Aerospace Corp.,** El Segundo, Calif., for work on ballistic missile and space programs.

$3,715,000—**Avco Corp.,** Stratford, Conn., for subsystems of a re-entry vehicle.

$3,000,000—**Stelma, Inc.,** Stamford, Conn., for electronic communications systems.

$2,700,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for launching services.

$2,520,321—**FMC Corp.,** New York City, for a special propellant, unsymmetrical dimethyl hydrazine.

$2,388,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for continued research, development and fabrication of space vehicles.

$2,200,000—**Aerojet-General Corp.,** Sacramento, Calif., for follow-on work on *Titan II* missile system.

$2,050,000—**Radio Corp. of America,** New York City, for telemetry data systems.

$1,600,000—**General Dynamics Corp., Astronautics Div.,** San Diego, Calif., for work on scientific space launch vehicles.

$1,250,000—**Kollsman Instrument Corp.,** Elmhurst, N.Y., for parts for astro-compass systems.

$1,100,000—**General Electric Co.,** Syracuse, N.Y., for modernization work on radars.

$1,100,000—**Dynamics Corp. of America,** Garden City, N.Y., for radar modification kits.

$1,048,256—**Aerojet-General Corp.,** El Monte, Calif., to field-test subsystems for the *Titan II*.

$600,000—**Milgo Electronic Corp.,** Miami, for an advanced Digital Instrumentation System.

$465,000—**Philco Corp., TechRep Div.,** Philadelphia, for engineering services.

$297,277—**TRW/STL,** Redondo Beach, Calif., for a test satellite for propulsion components and systems.

$216,000—**Gen. Tel. & Electronics Corp., Sylvania Electric Products, Inc.,** Williamsville, N.Y., to conduct an 11-month pseudo passive satellite technical study.

$102,723—**TRW/STL,** Redondo Beach, Calif., for a study of space propulsion system experiments utilizing environmental research satellites.

$59,000—**Honeywell, Inc.,** Minneapolis, for reentry vehicle control system design and mechanization.

$35,000—**Applied Research Associates, Inc.,** Concord, Mass., for minimum weight design concepts for aerospace structures.

The Garrett Corp., AiResearch Manufacturing Div., Los Angeles, to develop a miniaturized helium level refrigeration system suitable for use in space vehicles (amount undisclosed).

ARMY

$14,100,000—**ITT Federal Laboratories,** Nutley, N.J., for equipment and installation of communications systems.

$5,666,450—**North American Aviation, Columbus Div.,** Columbus, Ohio, for production of *Roadrunner* target missile systems.

$5,013,745—**Hercules Powder Co.,** Wilmington, Del., for assembling and packing Army missiles.

$2,100,000—**Hercules Powder Co.,** Wilmington, Del., for assembling and packing missiles.

$2,100,000—**Radio Corp. of America,** White Sands Missile Range, N.M., for missile development work at WSMR.

$1,900,000—**Continental Electronics Manufacturing Co.,** Brooklyn, N.Y., for radar maintenance at White Sands Missile Range, N.M.

$1,900,000—**FMC Corp.,** San Jose, Calif., for *Pershing* missile carrier production.

$1,700,000—**General Dynamics Corp., Pomona Div.,** Pomona, Calif., for further development work related to the *Mauler* weapon system.

$1,631,587—**General Dynamics Corp., Pomona Div.,** Pomona, Calif., for additional quality control effort under the feasibility validation program of the *Mauler* weapon system.

$1,500,000—**Capitol Radio Engineering Institute,** Washington, D.C., for classified services.

$1,272,567—**Bendix Corp.,** Teterboro, N.J., for ground support equipment related to the *Pershing* missile system.

$1,268,837—**Raytheon Co.,** Norwood, Mass., for electronics equipment.

$529,905—**American Elcon, Inc.,** Cape Canaveral, Fla., for construction of an instrumentation facility on the Moon launch complex.

$294,909—**American Elcon, Inc.,** Cape Canaveral, Fla., for furnishing and installing an electrical distribution system along Highway A1A in the Merritt Island launch Area.

NAVY

$19,928,127—**Thiokol Chemical Corp.,** Bristol, Pa., for production of LR62 packaged liquid engines for the *Bullpup* AGM-12C missile.

$8,300,000—**General Electric Co.,** Pittsfield, Mass., for production of fire-control systems for missiles.

$7,000,000—**Simplex Wire and Cable Co.,** Portsmouth, N.H., for coaxial cable for classified oceanographic research work.

$6,401,773—**Raytheon Co.,** Lexington, Mass., for radar sets for *Tartar* antiaircraft missiles.

$5,500,000—**Dynaelectron Corp., Paradyn Div.,** Washington, D.C., for data processing at the Pacific Missile Range.

$4,000,000—**Sperry Rand Corp.,** Great Neck, N.Y., for computers.

$3,200,000—**Gilfillan Corp.,** Los Angeles, for air surveillance radar equipment.

$3,100,000—**Sperry Raod Corp.,** Great Neck, N.Y., for *Terrier* missile radar modification kits.

$2,500,000—**Hughes Aircraft Co.,** Fullerton, Calif., for radar sets.

$2,420,000—**North American Aviation, Inc.,** Anaheim, Calif., to make Navy gyroscopes.

$2,000,000—**Goodyear Tire & Rubber Co., Goodyear Aerospace Corp.,** Akron, Ohio, for further development of the Navy's *Subroc* underwater missile.

$1,842,872—**Astrodata Corp.,** Anaheim, Calif., to produce a telemetry system.

$1,475,620—**Texas Instruments, Inc.,** Dallas, for engine ring services for *Shrike* missiles.

$1,406,496—**Bendix Corp.,** Mishawaka, Ind., for engineering studies on *Talos* missiles.

$1,300,000—**Frequency Engineering Laboratories,** Farmingdale, N.J., for ECM equipment.

$1,000,000—**Defense Electronics, Inc.,** Sherman Oaks, Calif., for RF telemetry-communications equipment and systems.

NASA

$16,975,000—**Blount Brothers Corp.,** Montgomery, Ala., for construction of three major elements of a unique space environment facility.

$5,000,000—**International Business Machines Corp., Federal Systems Div.,** Bethesda, Md., to supply technical services in support of the computation systems of Goddard Space Flight Center at Greenbelt, Md.

$4,900,000—**Documentation Inc.,** Bethesda, Md., for continued operation of the NASA Scientific and Technical Information Facility.

$1,300,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., to provide four RN-6 liquid hydrogen-cooled nozzles to be used as test items.

$1,125,000—**Ling-Temco-Vought,** Dallas, for a Dynamic Crew Procedures Simulator—a unique space research device that will permit astronauts to simulate orbital, lunar and interplanetary flights without leaving the ground.

$788,838—**Textron, Inc., Bell Aerospace Corp., Bell Aerosystems Co.,** Buffalo, N.Y., to develop a universal auxiliary rocket engine for use in future national space missions.

$621,510—**Hughes Aircraft Co., Santa Barbara Research Center,** Culver City, Calif., for the design and production of a dual radiometer assembly for NASA's project Scanar.

INDUSTRY

$2,000,000—**Fischbach and Moore, Inc.,** Dallas, from **S&S Constructors,** Lancaster, Calif., for instrumentation, data acquisition and control systems for the high thrust rocket research facility at Edwards AFB, Calif.

$1,300,000—**Beckman Instruments, Inc.,** Fullerton, Calif., from **Lear Siegler, Inc.,** Santa Monica, Calif., for two data acquisition systems and data processing digital computers to be used in development of the *Saturn* space vehicle.

$1,300,000—**Potter Instrument Co., Inc.,** Plainview, N.Y., from **UNIVAC Div. of Sperry Rand Corp.,** New York City, for production quantities of the Potter MT-36 digital magnetic tape traosport.

$1,000,000—**Electronics Associates, Inc.,** Long Branch, N.J., from **General Dynamics Corp.,** New York City, for a HYDAC 2000 hybrid digital analog computer system.

$570,015—**Rosemount Engineering Co.,** Minneapolis, Minn., from **Beech Aircraft Corp.,** Wichita, Kan., for production of altitude transducers.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Attention: AMSMI-IWB
Redstone Arsenal, Alabama 35809

Contract awarded to Douglas Aircraft Co., 1820 Statesville Ave., Charlotte, N.C., for *Honest John* rocket motors, training 762 M M98. Firms interested in subcontracting opportunities should contact the above.

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Attention: AMSMI-IWB
Redstone Arsenal, Alabama 35809

Contract awarded to North American Aviation, Inc., 4300 East Fifth Ave., Columbus, Ohio, for Type IV *Roadrunner* target missiles and engineering services. Firms interested in subcontracting opportunities should contact the above.

Office of Naval Research
Washington, D.C.

Negotiations to be conducted with Rocket Power, Inc., Mesa, Ariz., for further research involving the design and testing of meteorological sounding vehicles under Contract Nonr-3872(00). RFP not available; for information only.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland

Digital command system and remote units for DCS. RFP-T and DS-303 due 8/7/64. Address inquiries to Richard E. Egerter, Code 248.

Aeronautical Systems Division
Wright-Patterson AFB, Ohio 45433

Continuation of Contract AF33/657/-13325 to be negotiated with Collins Radio Co., Cedar Rapids, Ia., for computer flight director. RFP ASD-1886-WMI not available; for information only.

National Aeronautics & Space Administration
Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Texas 77058

Slow scan video test signal generator to be used to test and evaluate slow scan TV systems being developed for the *Apollo* LEM program. RFP MSC BG-731-35-5-6-P due 7/23/64. Copies available until 7/21/64.

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Attention: AMSMI-IWB
Redstone Arsenal, Alabama 35809

Contract awarded to Polarad Electronics Corp., 34-02 Queens Boulevard, Long Island City, N.Y., for spectrum analyzer, Model SA84WA, for Hawk missile system. Firms interested in subcontracting opportunities should contact the above.



New Product of the Week

Autocollimator

An automatic autocollimator using electro-optics to provide digital readout of mirror angles over a 1-degree operating range has been developed by Razdow Laboratories, Inc.

Precision ruled gratings and multiplier phototubes are combined within the reading head to produce an electrical signal that represents mirror angle. When the mirror is turned, the device tracks the movement and displays the new position on a 4-digit numerical indicator.

The device can track mirror rotation at a maximum slewing rate of 40 degrees/hour. No minimum tracking rate exists. Repeatability is 0.1 arc-sec. Resolution is 0.1 arc-sec.

Circle No. 151 on Subscriber Service Card

Rubber Compounds

General Electric Co.'s Silicone Products Dept. has introduced a line of silicone rubber compounds in the 40 to 80-durometer class.

The materials, SE-4511U, 4611U, 4711U and 4811U are designed for use in a temperature range from —75° to 500°F in vented systems. The compounds offer no-post-cure capability for application where desired.

Circle No. 152 on Subscriber Service Card

Coaxial Load

Microwave Development Laboratories, Inc., has developed a coaxial load operating over a frequency range of dc to 5,000 mc. The Model 50000-LK16F-NF measures 1.57 in. in length. VSWR is 1.15 maximum; impedance is 50 ohms.

Circle No. 153 on Subscriber Service Card

Voltage Panel Meter

An expanded scale ac line voltage panel meter meeting MIL-10304B specifications is available from Expando Meter Co., a division of A&M Instrument, Inc.

The Model 431 has a voltage span of 100 to 130v RMS at a frequency of 50 to 500 cycles. Units are available with sensitivities of 333, 500, 1,000 or 10,000 ohms per volt with accuracies of ±0.25% at 25°C and ±0.5% from 0 to 65°C. The meter can withstand instantaneous overloads of 300%, one minute overloads of 200% and continuous overloads of 150%, all full scale values.

Circle No. 154 on Subscriber Service Card

Rotary Solenoids

Ledex, Inc., is marketing a line of rotary solenoids with a minimum life expectancy of 100 million operations. The units are available in six sizes with torque output ranging from 0.8 to 27 lb.-in.

Operating life is achieved by application of a factory-supplied lubricant at 10-million-cycle intervals. Without lubrication, life expectancy is 50 million actuations.

Circle No. 155 on Subscriber Service Card

Modulator

Transmagnetics, Inc., is marketing the Model 150 solid-state compact modulator, designed to replace the complex servo modulator.

The unit has a linearity of better than 0.1% full scale; dc input is 0 to ±10v into greater than 100 k ohms; output is 0 to 1v, 400 cps, into 50 k ohms. Offset and drift are less than 0.5 mv over a temperature range of —55° to 85°C. Excitation is 26v, 400 cps.

Circle No. 156 on Subscriber Service Card

Electronic Thermometers

Atkins Technical, Inc., is marketing a line of electronic thermometers providing a 0 to 50-mc linear output signal of better than 99%.

Linear signals of 10°, 20°, 50° and 100° at spans between —50° and 300°C can be fed directly from indicator to any recorder. Maximum deviation from linearity is 0.5%. Interchangeable thermistor sensing probes, located up to 4,000 ft. from the recorder, permit close thermal coupling for measurement of air, gas, liquid, surface and soft solids. Input is 105 to 125v ac.

Circle No. 157 on Subscriber Service Card

Parameter Tester

General Micro-electronics, Inc., is marketing a dc parameter tester able to accommodate flat-pack and TO-type packages with up to 14 leads.

The Model 1002 has pluggable program and permutation switches permitting up to 144 test parameters. Six programmable voltage supplies are provided, adjustable from the front panel. Stability is 0.1% on all voltage and current ranges. Setting accuracy is ±1 millivolt. Readout is customer-supplied digital voltmeter or equivalent.

Circle No. 158 on Subscriber Service Card

Ionization/Pirani Gauge

Consolidated Vacuum Corp. has developed a combination ionization gauge and Pirani gauge for monitoring pressures in the 1×10^{-9} to 2-torr range.

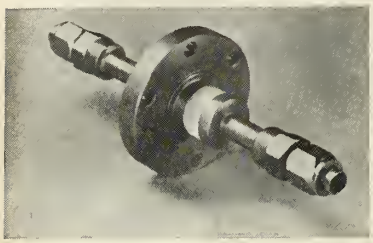


The ionization pressure is indicated on a single logarithmic scale in addition to the five-decade linear scale. Logarithmic range is 1×10^{-9} to 1×10^{-3} torr. The Pirani accessory has a 1 to 50-micron linear scale and a second range covering 50 microns to 2 torr. The device features automatic emission control with ±2% stability full scale with line variations of 105 to 130v.

Circle No. 159 on Subscriber Service Card

Cryogenic Feed-Thru

Advac Products, Inc., is marketing a line of flange-mounted cryogenic feed-thrus. The device consists of a ceramic-to-metal seal element used as a thermal barrier and a stainless steel feed-thru



tube with disconnect couplings at each end.

The unit is available in three tube diameters: ⅜ in.; ½ in.; and ¾ in. Four sealing methods are available: blank; O-ring; metal wire seal and interference.

Circle No. 160 on Subscriber Service Card

Arc Welder

A three-phase constant voltage arc welder rated at 250 amp, 100% duty cycle, is being marketed by Miller Electric Manufacturing Co.

The Model CP-250-TS can be used with any solid wire electrode dispensing equipment using the short circuit metal transfer method. It provides seven slope settings and controlled arc voltage. A voltmeter, ammeter and primary contactor, which can be used for 115v or 24v operation, are standard equipment. A 0.5-kva control transformer provides ac power for the feed and control unit.

Circle No. 161 on Subscriber Service Card

Miniature Filter

A miniature linear-phase low-pass filter with a passband of 0 to 4,000 cps has been developed by the Electronics Div. of Bulova Watch Co., Inc. The device meets MIL-F-18327 and NASA NPC-200 specifications.

The Model LP 500 has a rolloff rated at 40 db/octave. Input and output impedance is equal to 470 ohms. The hermetically sealed unit has a mounting area of ½ x 2¾ in.

Circle No. 162 on Subscriber Service Card

Silicon Rectifier Diodes

A line of medium-power silicon rectifier diodes, Type 402, is available from Westinghouse Electric Corp.'s Semiconductor Div.

The diodes are rated at 40 amps with low reverse-leakage current, but can be used at currents up to 70 amperes with proper cooling. Maximum 1-cycle surge current under load is 1,000 amps peak; maximum reverse-voltage ratings are up to 1,000v peak. Operating temperature is —65° to 200°C.

Circle No. 163 on Subscriber Service Card

Display Generator

United Aircraft Corp's Norden Div. has developed an alphanumeric display generator that permits display of computer data on a standard television receiver. The microelectronic system can accept 6 teletype messages of up to 180 characters each and can display two messages simultaneously.

Circle No. 164 on Subscriber Service Card

Carbon Potentiometer

Clarostat Manufacturing Co., Inc., has available a hot molded carbon potentiometer rated at 0.5 watts and measuring ½ in. in diameter.

The Series 63M uses a fused and polymerized base incorporating the carbon resistance element, terminals and base structure in a dielectric strength assembly. The contact spring is beryllium copper. The unit is designed to meet all applicable military specifications.

Circle No. 165 on Subscriber Service Card

Potentiometer

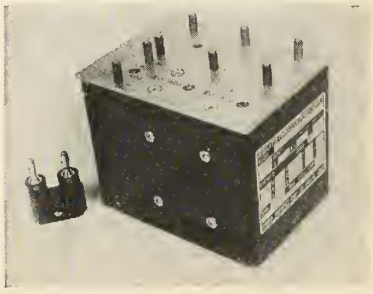
Bourns, Inc., is marketing a 10-turn potentiometer featuring resistances from 100 to 100,000 ohms, standard linearity of ±0.5% and resolution to 0.01%.

The Model 3507 has a power rating of 2.0 watts at 25°C. Operating temperature range is —55° to 105°C. Vibration is 10 g's, 55 to 2,000 cps. Shock is 50 g's.

Circle No. 166 on Subscriber Service Card

Power Supply

A miniature power supply to power random access core memories in airborne computers has been developed



by Arnold Magnetics Corp.

The Model SHX86D provides 3 regulated and electrically isolated outputs from a 28v dc source. The unit meets MIL-E 5272D specifications.

Circle No. 167 on Subscriber Service Card

Recording Isophotometer

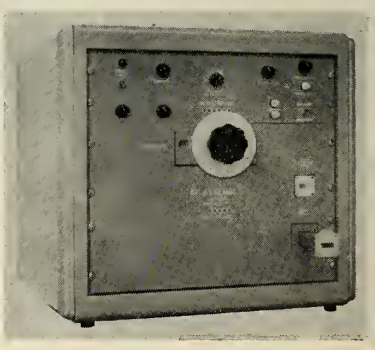
An instrument that automatically maps the density of film transparencies and glass plates has been developed by Technical Operations Research.

The Isodensitracer can scan, measure and plot all points in a 7 x 9-in. tracing in approximately one hour. The device measures densities up to 6 D on specimens measuring up to 5 x 10 in. Specimen to record magnification ratios are from 1:1 to 1:2,000. Maximum detecting resolution is 1 micron.

Circle No. 168 on Subscriber Service Card

Impedance Plotter

Rantec Corp. is marketing a series of automatic impedance plotters, providing swept-frequency impedance, admittance and reflection coefficient measurements. Interchangeable RF assemblies can be swept over a complete standard waveguide band or any portion



of it without adjustment. Four models are available covering the frequency ranges of 5.4 to 18.0 gc.

Circle No. 169 on Subscriber Service Card

Servo Accelerometer

Larson Aero Development has available a servo accelerometer featuring an acceleration signal electrically isolated from the power supply.

The ISO-JAN model uses a single 28v dc power source and has an output of ±5v dc. A dc-to-ac-to-dc converter provides the signal isolation, thus allowing usage in applications where feedback or crosstalk might arise.

Circle No. 170 on Subscriber Service Card

Environmental Test Chamber

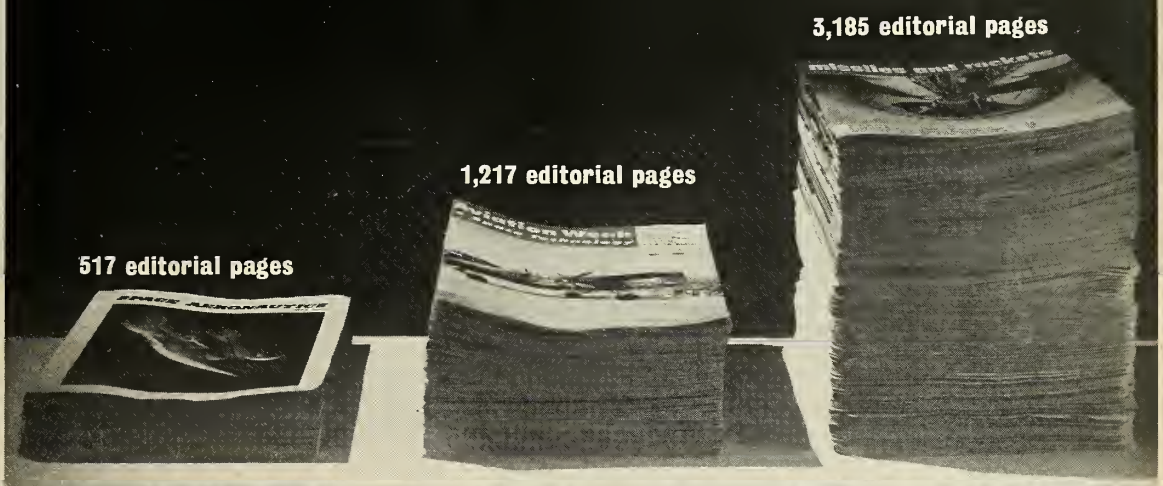
A trailer-mounted environmental test chamber with a capacity of 672 cu. ft. is available from Webber Manufacturing Co., Inc.

The Model AF-672-100/200 has an adjustable temperature range of —100° to 200°F. Air-cooled refrigeration units require electrical service only. Inside dimensions are 8 x 12 x 7 ft.

Circle No. 171 on Subscriber Service Card

Who informs

the missile/space—aviation—military markets?



CONOVER-MAST PUBLICATIONS
Space/Aeronautics

McGRAW-HILL
Aviation Week

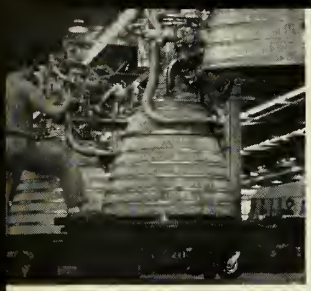
AMERICAN AVIATION PUBLICATIONS
Missiles and Rockets
American Aviation
Armed Forces Management
Air Cargo
Missile/Space Daily
Aviation Daily

AMERICAN AVIATION PUBLICATIONS boasts the largest editorial staff—38 full time editors and a global network of 20 correspondents—reporting developments in the missile/space—aviation—military markets. That's why readers of **AMERICAN AVIATION PUBLICATIONS** are among the best informed in the world.

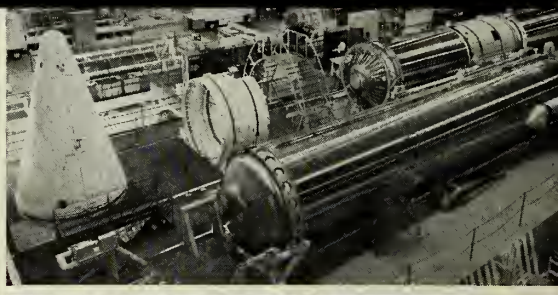
"SPECIALIZED MEDIA FOR SPECIALIZED MARKETS"

Total editorial pages published first five months 1964. Page count by Market Research Department, American Aviation Publications.

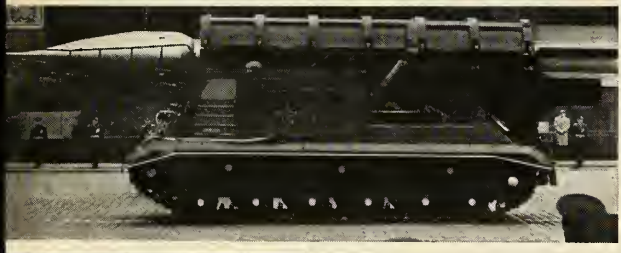
missiles & rockets 8th annual **WORL**

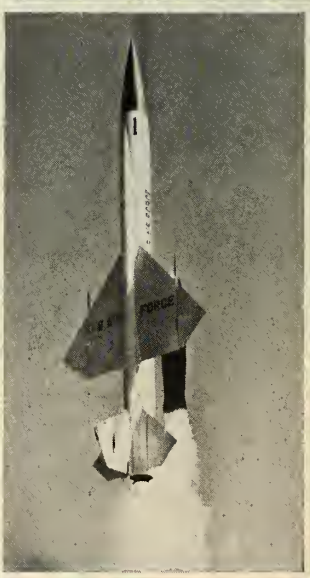
























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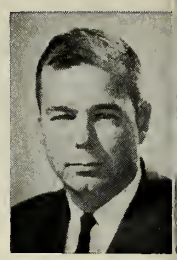
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names in the news


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LEWIS

Raymond T. Ruder: Elected to board of directors, Vitro Corp. of America, New York City. He is also vice president-finance and treasurer. **G. Russell Tatum:** Elected to board of directors, Vitro Corp. He is vice president in charge of technological activities and president of the Vitro Laboratories div.

Dr. Harold Goldberg: Named vice president of Ling-Temco-Vought, Inc., Dallas. He will later become general manager of LTV Military Electronics Div., Garland, Tex.

Frank Pace, Jr.: Elected director of Electronic Specialty Co., Los Angeles.

H. M. Conner: Appointed director of public relations for Aerospace Industries Association of America, Inc., Washington, D.C. He replaces Burton E. English, who has been named assistant to the president of AIA.

F. V. Wagner and **W. L. Frank:** Named to the board of directors of Informatics, Inc., Sherman Oaks, Calif. Wagner is vice president-plans and programs; Frank is vice president-eastern operations.

Dr. Brian D. Henshall: Appointed director of Aeromechanics subdivision, Aerospace Corp., San Bernardino, Calif., Operations.

John W. Wolcott: Appointed senior vice president of Ametek, Inc., New York City.

Daniel B. Callaway: Named vice president-sales and general sales manager of Industrial Acoustics Co., Inc., New York City.

G. D. Bradley: Named vice president-industrial relations of The Garrett Corp., Los Angeles. **Carl F. Fisher:** Appointed treasurer of the company.

Clifford A. Warren: Named associate executive director of the Defense Systems Div., Bell Telephone Laboratories, Whippany, N.J. He will be responsible for all aspects of the firm's role in the *Nike-X* research and development program.

Donald E. Butler: Elected vice president-marketing of Stainless Steel Products, Inc., Burbank, Calif.

Dr. Khaled M. Diab: Appointed senior scientist at Sylvania Electric Products, Inc., Buffalo, N.Y.

Miles A. McLennan: Joined Lockheed Missiles & Space Co., Sunnyvale, Calif., as head of the firm's activities in bioinstrumentation.

Henry W. Gauger: Appointed manufacturing manager of Micro Systems, Inc., Pasadena, Calif. He will be responsible for production planning and control and all fabrication operations of the firm.

Denny E. Henneman: Appointed product sales manager for the transducer and mechanical product lines of Allegany Instrument Co., Cumberland, Md.

Robert F. Burns: Appointed corporate marketing manager in the Washington, D.C., area for Philco Corp., Philadelphia. Burns has named **R. Wiley Marr** to cover the National Aeronautics and Space Administration, **Milton L. Snyder** to cover other civilian agencies and **Ivan A. Humphrey** to cover military space agencies.

Howard B. Lewis, Jr.: Named director of advanced engineering for the Transducer Div. of Consolidated Electrodynamics Corp., Pasadena, Calif.

Norbert St. John: Appointed manager of inside sales and procurement for Hamilton Electro Sales, Culver City, Calif.

Herb Kuebrich: Named works manager of the Northwest Industries, Inc., Albany, Ore.

Manning Holoff: Appointed general manager of the Aerospace Div. of Greer Hydraulics, Inc., Los Angeles.

James D. Wood: Appointed director of advertising and public relations of the Univac Div. of Sperry Rand Corp., New York City.

Rex Hodge: Named field engineer for the New England area for Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio.

Frank W. Crook: Appointed sales manager at Brooks Research, Inc., East Rochester, N.Y.

Jack T. Wills: Appointed to the corporate marketing staff of The Marquardt Corp., Van Nuys, Calif.

when and where

JULY

Aerospace Electrical/Electronic Supersonic Symposium, "Supersonic Aircraft—Avionics at Mach 3 and Beyond," Aerospace Electrical Society, International Hotel, Los Angeles, July 14-15.

Fourth International Symposium on Rarefied Gas Dynamics, sponsored by the AF Office of Scientific Research, ONR, NASA and the University of Toronto, Toronto, Canada, July 14-17.

Briefing Conference on Government Contracting for Research and Development, Federal Bar Assoc. and the Bureau of National Affairs, Statler Hilton Hotel, Boston, July 15-16.

Gordon Research Conference on Critical Tables and Progress in Science, Air Force Office of Scientific Research, New Hampton, N.H., July 20-24.

International Congress on Semiconductor Physics, sponsored by the AF Office of Scientific Research, NSF, ONE and the International Union of Pure and Applied Physics, Paris, July 20-24.

Meeting of the American Crystallographic Assoc., Montana State College, Bozeman, July 26-31.

Sixth International Symposium on the Reactivity of Solids, International Union of Biochemistry, New York Hilton and Americana Hotels, New York City, July 26-Aug. 1.

"Random Processes in Communication Systems," Polytechnic Institute of Brooklyn's Farmingdale Graduate Center, Farmingdale, N.Y., July 27-31.

AUGUST

First Research Conference on Instrumentation Science, Instrument Society of America, William Smith College, Geneva, N.Y., August 3-7.

Fifth International Symposium on the Reactivity of Solids, International Union of Pure and Applied Chemistry and International Union of Pure and Applied Physics, Munich, Germany, August 4-10.

12th Annual Engineering Management Conference, Institute of Electrical and Electronics Engineers, ASME, AIIE, and ISA, Pick-Carter Hotel, Cleveland, Ohio, August 9-11.

Seventh National Heat Transfer Conference, American Institute of Chemical Engineers and American Society of Mechanical Engineers, Sheraton-Cleveland Hotel, Cleveland, Ohio, August 9-12.

Structural Developments in Inorganic Chemistry and Their Chemical Implications, AF Office of Scientific Research, New Hampton, N.H., August 10-14.

Contracts Seminar, Department of Defense and the National Association of Professional Contract Administrators, Orlando, Fla., August 10-13.

Thirteenth Annual Conference of Applications of X-Ray Analysis, Metallurgy Div. of Denver Research Institute at the Univ. of Denver, Albany Hotel, Denver, August 12-14.

1964 Cryogenic Engineering Conference, University of Pennsylvania, Philadelphia, August 12-14.

Tenth International Symposium on Combustion, Combustion Institute and Cambridge Physical Chemistry Dept., Cambridge University, Cambridge, England, August 17-21.

International Astronomical Union Symposium No. 25, AF Office of Scientific Research, International Astronomical Union, Government of Greece, and University of Thessaloniki, Thessaloniki, Greece, August 17-22.

Conference on Interference and Coherence, International Commission for Optics and Australian Academy of Sciences, Sydney, Australia, August 24-25.

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, August 24-26.

Fourth Congress of the International Council of the Aeronautical Sciences, International Conncil of the Aeronautical Sciences and American Institute of Aeronautics and Astronautics, Paris, August 24-28.

Ninth Annual Technical Symposium, Society of Photo-optical Instrumentation Engineers and USAF Eastern Test Range, Deauville Hotel, Miami Beach, Fla., August 24-28.

Western Electronics Show and IEEE Summer General Meeting, Philadelphia Sheraton Hotel, Philadelphia, August 25-28.

12th General Assemhly, International Astronomical Union, University of Hamhurg, Hamburg, Germany, August 25-September 3.

Gravity Day, sponsored hy the Gravity Research Foundation, New Boston, N.H., August 29.

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That Manpower 'Shortage'

THE QUESTION of whether there is an impending shortage of technical manpower in the United States, with its implication that the space program is a disproportionate drain on the supply, is a controversial one. Two current and contrasting reports on scientific and engineering manpower shed interesting light on the problem.

The first is the recently released survey of the Engineering Manpower Commission of the Engineers Joint Council, a group including representatives from 20 engineering societies. The second is a report by a Presidential Committee on Utilization of Scientific and Engineering Manpower, released today.

The Engineering Manpower Commission once again has carried out a detailed statistical survey of actual scientific and engineering employment and projected employment needs of more than 500 industrial firms. It contains some major surprises for those who have been telling us that the nation is faced with a shortage of well over a million scientists and engineers before the decade is out.

First, as far as scientists are concerned, the commission report indicates that the projected supply may be entirely adequate to meet the projected demand.

The survey confirms that there may well be a shortage of graduate engineers, but far below the alarming proportions which have been so widely described.

Perhaps the most significant statistic in the entire report is that for projected 10-year growth in total engineering employment. Two years ago, the respondents set this figure at 44.7%. The 1964 projection is for a 26.2% growth.

The first obviously forecast a demand which greatly exceeded the normal national growth rate. The second is much more in line with the normal growth in Gross National Product to be expected over the next 10 years.

Since the survey covers a variety of industries, the leveling of defense expenditures in the current fiscal year cannot be held accountable for such a drastic reduction in projected employment figures. It appears that in 1964 many firms have a much more conservative projection of future engineering manpower needs.

But perhaps the most significant thing about this rapidly shifting statistic is the degree of change in only a two-year period. If this can happen in only two years, how then can any projection of technical manpower needs for a decade be valid?

Political decisions on national goals, military decisions on requirements, and the cyclical rise and fall of the business barometer play too great a role in such projections to consider them valid.

Having said that, we might note that the commission's statistics carried to a reasonable conclusion would indicate a shortage of engineers in 1973 on the order of perhaps 100,000. We hasten to point out that the commission did not carry its projections to such a conclusion. But this number is far below that usually cited and is one which could be met with moderate measures.

One intriguing aspect of the survey is that the companies responding indicated a far higher demand in the future for new graduates than for experienced engineers. This may indicate that many firms have learned how to more economically utilize technical manpower by placing the fresh college crop in groups under the direction of a single more experienced hand, thus reducing the number of older men needed.

This projected need for new graduates is significant even now. Responding organizations reported that the hiring of experienced engineers with degrees dropped 11% between 1962 and 1963. This drop was much sharper than the 6% drop in hires of new engineering graduates and provides an overall fall-off in recruiting of 8%.

Figures for the aerospace industry in 1963 vary somewhat from the norm. Total new hires in 1963 were off 16.6%. New graduate hires were down 22.6%, while experienced hires were down only 16.2%. Projections for 1964 show the shift in favor of new graduates, however. In the aerospace industry, the projected reduction of 10% in 1964 recruiting goals is entirely in the category of experienced engineers.

"Judging by the results of the report," says William M. Hoyt, chairman of the commission, "employers will maintain active recruiting programs for new engineering graduates, especially those with some advanced training. When hiring experienced engineers, employers will probably concentrate on obtaining only high quality men with training in the field specifically related to particular openings."

For those interested, the report ("Demand for Engineers, Physical Scientists, and Technicians—1964") can be obtained from the Engineering Manpower Commission, 345 E. 47th Street, New York, N.Y. Price: $4.00 a copy—prepaid.

THE PROJECTION OF A 26% GROWTH in engineering employment over the next decade in the commission's report is far below not only its own earlier 45% figure but also the fantastic 67% increase prophesied by the U.S. Dept. of Labor, which was used as a base for the Presidential committee report released today.

The report of the impressive Presidential committee shows little real effort toward obtaining a realistic picture and its conclusions are so filled with platitudes that it is not worth reading. Its most worthwhile contribution is to demonstrate the folly of asking such a high-level group to take on a chore for which they obviously did not have the time or interest.

William J. Coughlin



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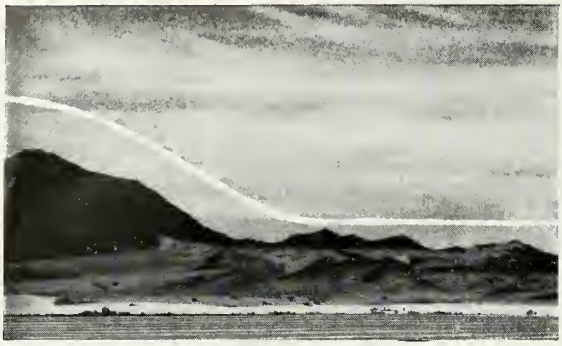
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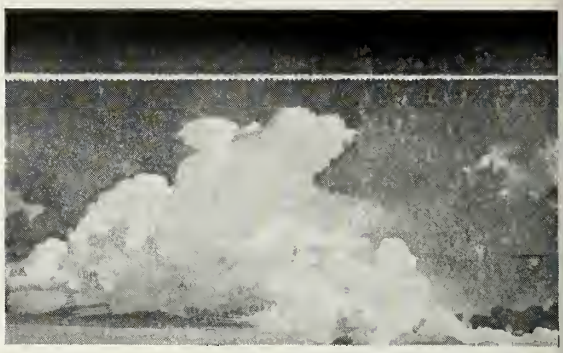
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

JUL 1964
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Volume 15, Number 3 July 20, 1964

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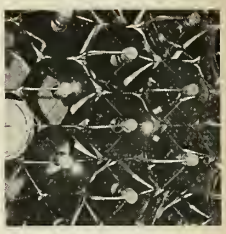
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THE COVER



A cluster of optical modules is shown in solar simulator of Goddard Space Flight Center's space environmental simulator. Solar simulator consists of 127 of these modules boxed in the dome of the space environmental simulator, which went into operation this month. See story, p. 34.

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Is this what most engineers mean when they say RELIABILITY?



A radar system that enables the pilot to deliver weapons on target—from high or low altitudes, in any weather, day or night.

That is reliability. The F-15 and R-14 radars have proven their reliability in both MTBF tests and actual operating conditions. These multimode, monopulse systems were developed by North American Aviation/Autonetics. F-15 equipped F-104 Starfighters are used by NATO, MAP and the Canadian Air Force. The R-14 is in the USAF F-105 Thunderchief. These radars have target-on-time impact capability with a high degree of accuracy. Autonetics supports these systems and ensures proper training, maintenance and modification with rapid service and technical assistance anywhere in the world. Now Autonetics is leading the industry into production application of microelectronics for even more versatile radar systems with still greater reliability. These are but some of the many achievements by engineers and scientists at Autonetics in integrated, cost-effective systems. These achievements set the standards of reliability for the entire electronics industry.

North American Aviation/Autonetics

letters

Clear Centaur Report

To the Editor:

Some of the press reports on the *AC-3 Centaur* flight made me think we were back in 1957 again, trying to educate reporters on how to report a technical story accurately. So it was a special delight to read a straightforward report in your book (M/R, July 6, p. 10).

J. R. Dempsey
General Dynamics/Astronautics
San Diego, Calif.

ESP and Khrushchev

To the Editor:

Recent letters to M/R have indicated an increasing scientific interest in ESP, which is a good omen. Perhaps when more government officials become interested in ESP, the nation will not be so easily deceived by Mr. Khrushchev and his Hollywood-TV horseopera showmanship. Most Americans—but apparently not government officials—who watch TV know that a gunslinger's next move, after he exposes his hat-on-a-stick, is to sneak behind his enemy and shoot him in the back.

Khrushchev exposed his hat-on-a-stick in Cuba in the fall of 1962, just prior to the U.S. elections. Now he is building nuclear submarines to operate from future submarine bases in Cuba. These submarines will be very effective weapons against our space program, which is now located primarily in the soft underbelly of the United States.

Perhaps the Defense Secretary should study parapsychology instead of statistics. He might discover why the U.S. has about four times as many nuclear-tipped ICBM's as the USSR—yet the Russians achieve the same deterrent capability while the U.S. grows weaker.

LeRoy F. Iverson
Denver, Colo.

Not Guilty

To the Editor:

The "unveiling" of RCA's "Stabilite" (M/R, June 29, p. 34) should have included a reference to U.S. Patent No. 3,048,108 (Satellite Stabilizer), filed Sept. 7, 1956, and granted Aug. 7, 1962, to R. E. Roberson, et al, assignors to North American Aviation, Inc. Although I make no specific claims for the patent (which speaks for itself), I would like to suggest that there is nothing "new" about the use of a pitch wheel for satellite stabilization and/or pitch angular velocity control. Furthermore, the implication that the "wheel technology" is a new concept in satellite configuration and control should be avoided in the interests of historical accuracy.

The referenced Patent claims include:

"1. Means for stabilizing a satellite vehicle . . . said stabilizing means including a rotatable wheel attached to said body, the plane of rotation of said wheel being oriented with respect to said body so as to be parallel with said orbital plane of said body, means for controlling the speed of said rotating wheel according to the pitch angular velocity of said body."

L. H. Grasshoff
Los Angeles, Calif.

M/R did not say, or intend to imply, that "Stabilite" is a new concept; we said the specific system is new. The article in question cited Tiros as an example of previous wheel configuration technology.—Ed.

Layoff Victims

To the Editor:

I am writing this in behalf of electrical, mechanical, instrumentation and other people who make, or try to make, a living in the missile business.

This special type of people must work as a team to accomplish some feats that would offer an overwhelming challenge to the most brilliant scientist.

A good part of America's economy is built on waste of material and even on the waste of talent, which takes many years to develop.

Few people are aware of the sincerity and devotion that these people cultivate to make an R&D or operational program go. Special skills must be developed and used, and years of knowledge must be put into a mental bank, to compete for this type of work. Decisions must be made that degreed engineers sometimes cannot answer.

The dangers involved in this type of work are many, and some are hidden.

I am one of the people who has been laid off, and I must make it known what a terrible waste is being caused by layoffs.

Political machines, government project timing and fiscal year funding are common causes for such waste.

Surely someone is aware of this onslaught. The economy of the cities and towns that depend on these people for business is affected.

Employes are leaving this type of work because of the small reward and the large outlay for moving and leaving homes to go to waste. Pay is good—provided the town you live in doesn't try to monopolize on your earnings.

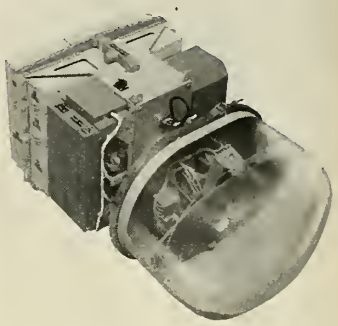
I must say that the company I worked for treated me very well, and they were just as regretful as I about the layoff.

An on-the-job training program should be started to train (laid-off) people for engineering degrees and the like. This would relieve some of the colleges now cramped for space.

The people involved think enough of their country to tolerate sometimes unbearable conditions. Such conditions will cease to exist if they are presented to the right people, and if these people are interested enough to try to correct them.

Kenneth L. Gardner, Jr.
Nipomo, Calif.

And is this what most engineers mean when they say APPLIED MICROELECTRONICS?



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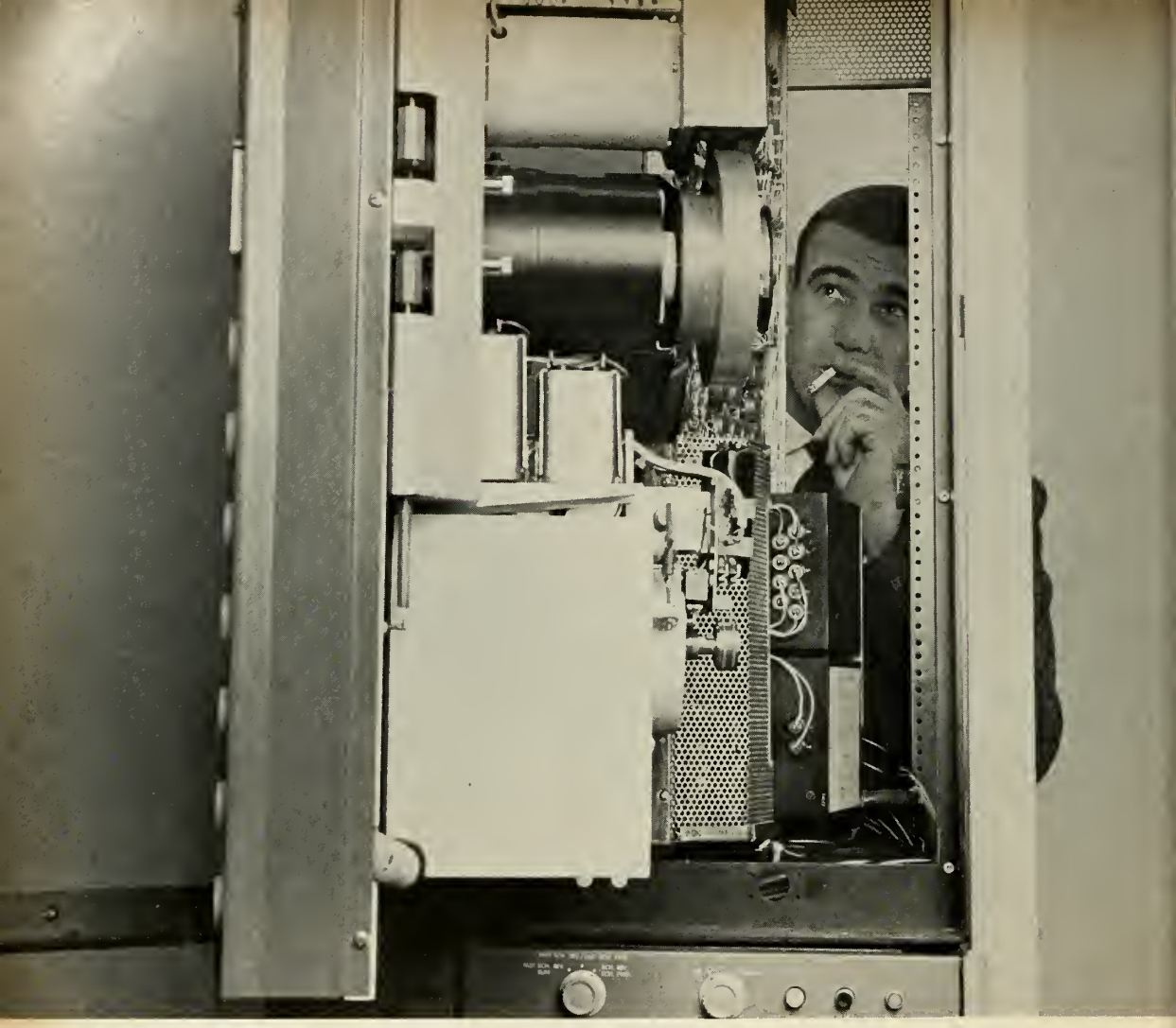
The R45 radar family was designed to fulfill a need for reliable, lightweight, easily maintained and versatile airborne systems at low cost. These building block systems weigh less than 100 pounds and have more than a 1000-hour inherent mean-time-between-failure rate in helicopter, transport and light attack applications. Basic K_u band frequency and 60 kw power can be varied to meet customer operational requirements.

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The Countdown

WASHINGTON

Post-Apollo Assessment Due Soon

NASA's report on its post-*Apollo* mission plans—ordered by the White House—is being prepared by a special group directed by Francis Smith, assistant director of Langley Research Center. The panel is concentrating on relating requirements for research and development leading up to the future programs. It hopes to make its report to Administrator James E. Webb in a few weeks. Three top-priority projects so far are *Voyager, Extended Apollo* and the *Lunar Exploration System for Apollo* (*LESA*).

McNamara Didn't 'Cancel' LASV/Pluto

Secretary of Defense McNamara has denied cancelling the *Low-Altitude Supersonic Vehicle* (*LASV*) program. What he did, according to Mr. McNamara, was point out to the Atomic Energy Commission that chances of the system being deployed were so slight that they brought into question the usefulness of a $250-300 million flight-test program and a $1-billion development program.

MOL Fuel Cell Pact Being Negotiated . . .

Allis-Chalmers Research Div. is discussing with the Air Force Space Systems Div. a study of the fuel cell power supply requirements for the *Manned Orbiting Laboratory* (*MOL*) program. The study will be performed over a three-month period.

. . . And Lockheed Awaits LORL Study Award

Lockheed Missiles and Space Co. is expected to receive a contract from NASA in the near future for a nine-month, $300,000 study of a *Large Orbiting Research Laboratory* (*LORL*). The firm recently released details of its Olympus concept—a 200,000-lb. *LORL* capable of supporting 24 men on long-duration missions.

Hughes Studying Advanced Radar

An Advanced Design Array Radar (ADAR) that may have application to air defense of cities is under study for the Air Force's Rome Air Development Center by Hughes Aircraft Co. The contract will run for 15 months and calls for some feasibility hardware development. RCA's Missile and Surface Radar Div., Moorestown, N.J., will design the transmitter subsystem, and Western Microwave Laboratories, Palo Alto, Calif., will design a microwave switch. Contract is estimated at $1.5 million.

MAR Operating at White Sands

A prototype of the Multi-Function Array Radar (MAR), key to the *Nike-X* system, has been in operation since July 1 at White Sands Missile Range. Tests of the MAR are expected to yield important inputs for the *Nike-X* decision, in terms of ability of a single radar to handle acquisition and discrimination of multiple targets. However, Defense Secretary McNamara says it will be late this year before enough information has been gathered for a decision on deployment of the *Nike-X*.

Three-T Job Wins Top-level Kudos

Secretary McNamara has praised the Navy for "a magnificent job" in correcting the deficiencies of the *Tartar, Talos* and *Terrier* shipboard antiaircraft missile systems. Some $275 million is being spent to increase the kill probability of the systems. This is over and above the $1.4 billion invested in development of the three weapons.

Nimbus Now Slated to Go Aug. 6

Launch date for the heavy *Nimbus* meteorological satellite is now set at Aug. 6. It will be fired into a polar orbit from the Western Test Range. The satellite was originally scheduled for launch in mid-1963.

NASA Parts Data Bank in Works

Space agency officials now hope to have a Preferred Parts List Data Bank operating by the end of the year. An agency task force is currently visiting all field centers to gather information for the system, which will provide data on reliability of high-usage parts and components.

INDUSTRY

Aeronutronic To Run Army Shillelagh Plant

The General Services Administration is turning over a former Air Force facility at Lawndale, Calif., to the Army, which will utilize it for mass production of the *Shillelagh* missile and guidance and control equipment. Aeronutronic Div. of Philco, which will receive a production contract in the near future, will operate the plant for Army's Weapons Command. Formal transfer of the 205,000-sq.-ft. facility will take place in the next two to three months.

Grumman Buying LEM Simulators from Link

Grumman Aircraft Engineering Corp. will begin at the end of July to negotiate with Link Div. of General Precision a contract valued at $5.9 million for design, development, and manufacture of two mission training simulators for the *Apollo* Lunar Excursion Module. The simulators will be exact replicas of the LEM internal configuration, including all instruments, displays and operational modes. They'll be updated after each manned LEM flight.

Atlas F's Refurbished Ahead of Schedule

The *Atlas F* updating program—Project Red Heat—will be bought off in the next three months by the Air Force, and the missiles will be returned to operational status at Walker, Plattsburgh, Dyess, Lincoln, Altus and Schilling Air Force Bases. The program, in which General Dynamics/Astronautics crews went into the field to update silos and missiles, is reported ahead of schedule and under estimated cost.

Guppy Flies LEM to Coast

Aero Spacelines' "Pregnant Guppy" has flown a mockup of LEM from the Grumman plant at Bethpage, L.I., N.Y., on a 13-hour trip to Long Beach, Calif., International Airport. The mockup is being delivered to North American's Space and Information Systems Div. to be test-mated with the *Apollo* Command Module adapter.

INTERNATIONAL

Next Alouette Shot Off Till Mid-'65

Alouette B, the Canadian-built satellite, has slipped from its previously scheduled launch in the last half of this year into the second quarter of 1965. It will be placed in a polar orbit by the *Thor-Agena* booster, and will weigh approximately 320 lbs.

$8M for Saturn

Marshall Space Flight Center has awarded three contracts totaling more than $8 million for work relating to upper stages of *Saturn* rockets.

Largest of the awards, $3.6 million, went to the Rocketdyne Div. of North American Aviation, Inc., for J-2 rocket engine production equipment at Canoga Park, Calif., and test support facilities at Santa Susana, Calif.

J-2 engines will power upper stages of the *Saturn V* and *Saturn IB* launch vehicles. Each engine produces 200,000 lbs. of thrust.

The other two contracts, $2.3 and $2.2 million, went to Douglas Aircraft Co. The preliminary $2.3 million award is to permit the firm to begin purchasing certain long-range items for eight additional S-IVB rocket stages, ordered for the *Saturn IB* program.

The $2.2 million will be spent for an additional set of automatic checkout equipment to be used on S-IVB stages at the Sacramento, Calif., test site.

Standard Engine Sought

A new liquid hydrogen-LOX rocket engine will be studied by Pratt & Whitney Div.'s West Palm Beach complex under a $685,000 pact with NASA's Marshall Space Flight Center.

The one-year study will use data produced under several separate NASA engine technology contracts at Pratt & Whitney with inputs from Aerojet-General Corp., Rocketdyne Div. of North American Aviation and General Electric Co.

Aerojet will supply information on combustion dynamics and on auxiliary components for high pressure engines; Rocketdyne will provide heat transfer, high pressure pump, high pressure cooling, toroidal chamber and aerodynamic nozzle data; General Electric will be the source of zero leakage information. Experimental cooling, combustion and high pressure pumping inputs will be handled by Pratt & Whitney.

The objective is to integrate existing feasible concepts into one engine best able to meet future requirements. Complete coordination will be effected with advanced launch and space vehicle studies at NASA.

The engine will be a single-chamber turbopump with variable mixture ratio control. The unit will be throttleable and capable of multiple restarts. Thrust range is pegged between 300,000 and 350,000 lbs.

The contract with Pratt & Whitney contains the provision that the cost to NASA will be only $500,000, with all other costs up to $185,000 being absorbed by the contractor.

Shots of the Week

The Air Force on July 8 achieved its first success in three launches of the *Athena* re-entry test series. The missile travelled 470 mi. from the Green River, Utah, launch site to a predetermined impact area at White Sands Missile Range carrying with it a subscale re-entry payload.

- A Strategic Air Command crew successfully launched an Air Force *Minuteman* ICBM from Vandenberg AFB, Calif., July 9. Target for the shot was 5,000 mi. down the Pacific Missile Range.
- The Soviet Union launched the 35th satellite in the *Cosmos* series on July 15.
- NASA on July 14 and 15 launched a total of seven *Nike-Apache* sounding rockets in the course of conducting two tests. Four were sodium vapor data collectors launched under a Goddard Space Flight Center program. The other three made measurements on the changes in the ionosphere between night and day. Launches took place from Wallops Island, Va.

Mace-B Ready in Germany

The *Mace-B* medium range missile has been declared operational at undisclosed points in West Germany. The missiles are installed in hardened concrete sites.

The 1,500-mi.-range *Mace-B* and the shorter-range *A* version are the only Air Force tactical missiles in Europe. Both have nuclear and high-explosive warhead capabilities.

House To Probe Spending

Two Congressional investigations into activities of industry and nonprofit defense contractors have been scheduled by the House Armed Services Investigations subcommittee.

Aerospace Corp. will be the subject of public hearings later this year on the firm's cost control policies. Subcommittee chairman Porter Hardy (D-Va.) said that the group has so far "found a number of expenditures" which did not immediately appear valid.

Hearings begin this week on expenses of West Coast defense contractors on "employee morale and recreation." Cases to be taken up include one in which a plane was used to fly a load of crabs across the country for a crab feast, and another involving the expenditure of several thousands for liquor and beer.

Titan III-A Nears Launch

The 71-ft.-tall first stage of *Titan III-A* has been installed at Complex 20, Cape Kennedy. The second stage, transtage and an aerodynamic hose shield are expected to arrive at the Cape in the near future.

The assembled vehicle, to form the core of *Titan III-C*, is scheduled to be launched late this summer. Launch of the *III-A* will be the first from Cape Kennedy of a vehicle specifically designed for a military space system.

The transtage was successfully test fired July 11 at Martin/Denver.

DDR&E Deputy Named

Thomas P. Cheatham, Jr., has been named Deputy Director of Defense Research and Engineering, Tactical Warfare Programs.

Formerly vice president of Litton Industries, Inc., he succeeds John L. McLucas, who will become NATO Assistant Secretary General for Scientific Affairs. Cheatham will be responsible for RDT&E tactical warfare programs and projects.

NASA Pact to General Atomics

General Atomics Division of General Dynamics Corp. has been awarded a contract covering studies related to the thermal tungsten rocket reactor concept.

The contract with NASA is expected to be worth about $1.7 million.

General Atomics will determine means to calculate the critical mass of uranium needed to provide reactivity, the distribution of uranium in the core for efficient thermal design and the ability of the control rods to perform their function. Gen-

eral Atomics also will devise experiments to confirm calculations reached in the study.

In a later phase of the program, critical experiments may be run on a mockup of the reactor.

Submerged Nozzle Tested

A fully gimballed rocket nozzle was successfully tested with 40% of its length submerged into the rocket motor case at Thiokol Chemical Corp.'s Wasatch Div.

The recessed nozzle concept is being investigated as a means to improve the performance of existing missiles without increasing their length. Such submerged nozzles permit an increase in propellant chamber length and hence more propellant.

The test motor generated 12,000 lbs. thrust in a 60-second run with propellant flame temperatures around 5,800°F. The nozzle was vectored up to ±8 degrees. During the firing, two hydraulic actuators moved the nozzle through several cycles of pitch, yaw and 45-degree-angle planes. All nozzle parts except the moveable housing and inlet were fabricated by Thiokol.

Aerojet Launches Ship

The oceanographic research vessel SPAR is now in its initial sea trials after being launched at Aerojet-General Shipyards, Jacksonville, Fla., last week.

SPAR will be instrumented and then towed to sea. Once at its assigned station, the 354-ft. vessel will be swung to the vertical by selective flooding and then will function as a stable platform for acoustics research. On station, only 20% of its length will be above the water line.

USS Biddle Renamed

The USS Biddle will be renamed the USS Claude V. Ricketts in honor of the late Vice Chief of Naval Operations.

The guided missile destroyer is a test ship for the Multilateral Force and will demonstrate the feasibility of mixed manning. Crew members are from Germany, Greece, Italy, the Netherlands, Turkey and the United Kingdom.

Lockalloy In Production

The Beryllium Corp. is producing Lockalloy (Be 62%-Al) sheet at its Reading, Pa., plant. The space-oriented alloy is a development of Lockheed Aircraft, and Berylco is producing the material under license. Dr. Raymond W. Fenn, Lockheed Missile and Space Co. staff scientist, says the metal development may lead to possible weight savings of 40% over HM21A-T8 and HK31A-H24 magnesium alloys.

Lockalloy extends the useful strength of light metals to service temperatures of from 600° to 800°F. Fabrication techniques common to light metals are applicable, according to Berylco.

Marquardt Gets Pact

Marquardt Corp. will proceed on the design and development of an advanced ramjet engine for the improved *Redhead-Roadrunner* target missile.

The firm was authorized by North American Aviation, Inc.'s Columbus Div., developer of the Army missile, to construct a scaled-up model of the operational 16½-in.-dia. engine. The design will extend the missile altitude-range performance. Marquardt is also required to modify the fuel control system to accommodate the larger advanced engine.

Design engineering and development and developmental testing will be conducted at Marquardt's Van Nuys, Calif., facilites. Engine and control system modifications will be done at Ogden, Utah.

Boeing Develops Fuel Tank

An elliptical cryogenic fuel tank manufactured by The Boeing Co.'s Aerospace Div. may be the forerunner of lightweight, insulated space vessels for cryogenic liquids. Boeing used production methods in fabricating the 8 x 6-ft. tank. Bulge forming, chemical milling and explosive sizing were the primary techniques. The aluminum shell, 0.040-in. thick, is covered with 50 alternate layers of aluminum foil and glass fiber insulation.

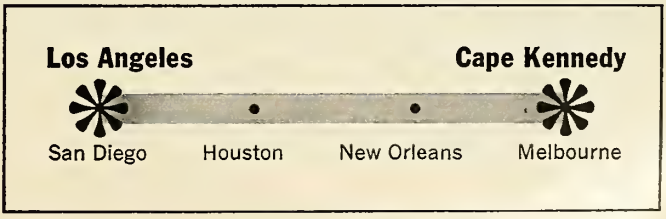
An outer shell of flexible aluminum 0.020 in. thick covers the tank. The unit will be moved to Boeing's Tulalip Test Facility next month for testing.

Cape Radio Service Formed

The Cape Kennedy Space Network, Inc., has been formed in Cocoa Beach, Fla., to provide year-around coverage of Cape space activities.

The service will be available to independent radio broadcast groups. The company estimates that at the time of the first manned *Gemini* flight, it will have over 100 reporters from all over the world. Founders are Wallis R. Kinney, Winter Park, Fla., Charles E. Varner, Indialantic, Fla., and Dean C. Wilson, Melbourne Beach, Fla.

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DOD To Develop Own Comsats

McNamara discloses that nine months of talks with ComSat Corp. failed due to consortium issue; MACS funding still to be worked out

by James Trainor

THE DEPT. OF DEFENSE has decided to proceed with development of the military *Medium-Altitude Communications Satellite (MACS)* system. Negotiations with the Communication Satellite Corporation have been suspended after nine months of talk.

Secretary of Defense Robert S. McNamara announced the decision at a news conference in response to a question. DOD has decided that participation in the civilian system "is not possible," he said, "much to my regret."

The issue on which the ComSat talks foundered was the draft international agreement for a consortium of 18 nations to own, operate and direct the management of the ComSat system. Specifically, DOD objected to the proposed voting rights clause and what it felt was the "potential rigidity of integration" of a DOD system into a civilian satellite program.

DOD will now proceed with full-scale development of the *MACS,* McNamara said, which has been funded at a low level in a post-program definition phase while the negotiations were being conducted.

One difficulty immediately facing the development of *MACS* is the fact that funds for the system were deleted from the House Appropriations Bill. DOD has asked the Senate to restore a portion of the $22 million for the Air Force and all of the $1.5 million for the Defense Communications Agency. If the funds are not restored by the Senate, DOD could finance FY '65 development from unused prior year funds, the Emergency Fund or reprogramming.

Defense officials now estimate that only $12.3 million will be required for Air Force development of the satellite system in this fiscal year. "Certain program slippages encountered after the 1965 budget was prepared have reduced our fund requirement by $9.7 million," Deputy Secretary of Defense Cyrus Vance told the Subcommittee on Defense Appropriations July 7.

● **Agreement close**—Right up until the first week in July, prospects for a DOD-ComSat agreement were bright. All technical problems had been resolved and all that remained were a few legal issues. However, when a working draft of the international agreement was circulated to government agencies, DOD took strong exception to the clauses which linked voting rights to ownership.

Under this arrangement, countries contribute to the development costs according to anticipated use of the system —and this contribution becomes a basis for voting rights. The U.S. would presumably provide 60% of the financing and thereby have 60% of the voting strength. However, other nations not initially members of the consortium could join within six months and be accorded voting rights. U.S. control thus could shrink to 50% of the votes.

Several "strong changes" in this arrangement were submitted by the Defense Department for consideration. However, the State Department rejected these amendments.

Another area of DOD concern was what was termed the "potential rigidity of integration." Specifically, DOD sought an exception for itself beyond the statement taking into account "special governmental needs" in developing a system.

What concerned DOD officials was the fact that the consortium would be given the power of decision, or at least review, of procurements over a certain dollar value—including selection of a system contractor as well as major subsystems. This, DOD felt, could prejudice its interests unless it were granted a specific exception clause in the agreement.

● **Negotiations complicated**—Since the start of talks with ComSat Corp. in November of last year, there have been several major changes in the DOD position. Initially, negotiations centered around the development and deployment of a synchronous orbit system. This was later supplanted by the medium-altitude random system.

Frequencies initially agreed upon were 8,000 mc up and 4,000 mc down. However, this was later changed to 8,000 mc up and 7,000 mc down for the military and 6,000 mc up and 4,000 mc down for the civilian system. The primary reason for this switch appears to be the interference from other electromagnetic radiators in the vicinity of a DOD antenna. Since military receivers must be located as tactical considerations dictate, this could be a major problem.

Finally, the earmarking of certain satellites for exclusive DOD use was superseded by the plan to put two transceivers in each satellite—one for the Dept. of Defense and one for civilian use. With this change, it looked as though all DOD requirements were satisfied and an agreement would be reached.

● **MACS development**—One of the major problems the Department will incur by not participating in the ComSat system is the loss of commercial capacity for military use. Primarily, this will mean that, without gravity-gradient techniques or "massive power," DOD will not be able to meet its requirements for tactical antenna requirements. Rather than 9-ft. dishes, the antennas may have to be as large as 30 ft.

MACS will be developed by a Philco/TRW STL team. It will consist of 24-30 medium-altitude random-orbit satellites multiple-launched by *Atlas-Agena.* The satellites are to be simple, lightweight basketball shapes with relatively low power. Development costs are expected to be $50-60 million. ■

If funds are cut deeply . . .

Mariner 1966 Mars Fly-by Mission May Be Cancelled by NASA

by Hal Taylor

THE SPACE AGENCY is seriously considering dropping plans for a Mars fly-by mission in 1966.

Officials have already cancelled development of a heavy (1,000-1,300-lb.) *Mariner* spacecraft, which would have been launched by the *Atlas-Centaur*.

To replace it, the Office of Lunar and Planetary Programs has proposed a spacecraft closely similar to the 570-lb. *Mariner* that will be launched toward Mars later this year.

This proposal is also running into opposition and may be dropped.

Dr. Robert C. Seamans, associate administrator, reportedly will not make a final decision on the project until the extent of Congressional cuts in the Fiscal 1965 budget is known. Sharp reductions would make the 1966 mission a likely candidate for the scrap heap.

Opponents also contend that a 1966 *Mariner* with a weight close to that of the 1964 *Mariner* spacecraft will not offer enough in additional instrumentation to make the project worthwhile. This opposition will intensify if the 1964 spacecraft successfully sends back TV pictures of the red planet.

● **Other developments**—Elsewhere in the unmanned space science program, it was learned that:

—JPL has taken the ultraviolet photometer experiment off the 1964 *Mariner* spacecraft because of technical problems with its instrumentation. The experiment was to determine the existence and amount of atomic hydrogen and atomic oxygen in the Martian atmosphere by looking at emission lines and spectra of those elements. This would have given an indication of water vapor in the atmosphere and thus helped to determine if life could exist in such an atmosphere.

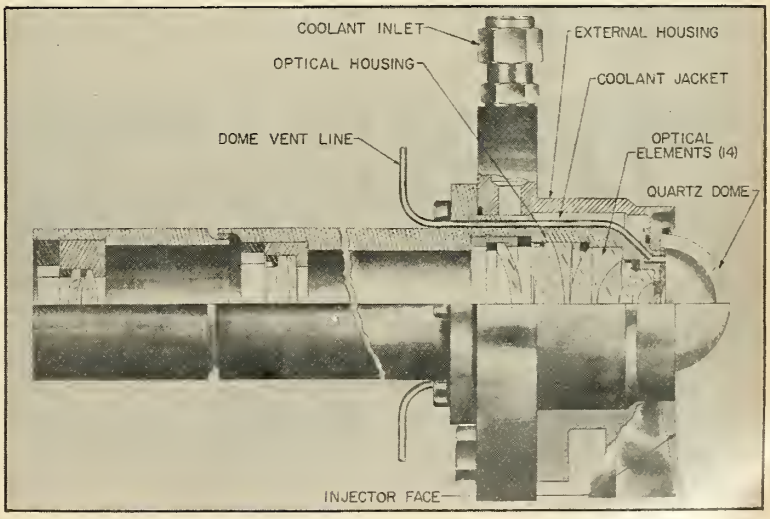
—No development funding for the *Advanced Pioneer* spacecraft will be requested in the FY '66 budget now being prepared by the space agency. Negotiations are now being held with General Electric Co. for a study of how such an interplanetary spacecraft could be used to explore the space region away from the Sun.

While the *Advanced Pioneer* will not be flight-tested until the 1970's, the *Mariner* program is a more immediate concern of space science officials.

Following the 1962 successful fly-by of Venus, the series will continue with two spacecraft to be launched on fly-by missions of Mars this year. While the UV photometer experiment has been dropped, some 60 lbs. of experiments will be carried along, including vidicon cameras to take pictures of the planet.

Originally the 1966 mission was to be an uprated version of the *Mariner* '64 spacecraft, which was to weigh about 1,000 lbs. Early plans also called for it to have a small capsule to be landed on the surface. Some thought was given to permitting industry to submit bids for the development of the spacecraft. In May and June of this year, the space agency decided to drop plans for the lander capsule. They also decided to shelve the heavy spacecraft.

If there was to be a *Mariner* 1966 mission, top management said, it should be based on proposals calling for the spacecraft to be built by JPL with a weight about equal to that of the 1964 spacecraft. ■



Aerojet Periscope To Study Thrust Chamber Interior

AZUSA, CALIF.—Aerojet-General Corp. has developed a special periscope to permit photographic scrutiny of the interior of an operating thrust chamber to study combustion instability.

Developed for the Air Force Rocket Propulsion Laboratory, Edwards AFB, under a $174,992 contract, the device, mounted in the injector of a liquid rocket engine, will allow a 160-degree field of view.

The periscope will use an Aerojet-built multi-element optical system, a cooling system, and a fused-quartz protective dome. It will have a stainless-steel housing, weigh 25 lbs. (without its 16-mm Fastex motion-picture camera), and measure 14 in. long, with a diameter of 2⅜ in.

The device will be installed in both an Aerojet 15-in.-diameter liquid rocket pulse motor and an engine using a modified *Titan* injector. Pictures taken with an operating *Titan* engine will establish the characteristics of engines using conventional injectors and determine how these characteristics correlate with the combustion instability as it exists in the pulse motor. ■

GOP Pledges 'More Orderly' Space Program, 'Revitalized' Military R&D

Convention platform stresses alleged dangers of diverting brainpower to space; renews 'no new weapons' accusation

by Heather M. David

THE REPUBLICAN PARTY will stretch out the U.S. space program and divert funds to other areas if Sen. Barry Goldwater (R-Ariz.) is elected President, the GOP platform indicates.

The document adopted by the 1964 convention in San Francisco pledges to "replan" the space program, providing for a "more orderly, yet aggressively pursued, step-by-step development." It called for more attention to the dangers of "overdiversion of skilled personnel" to the space program from such areas as health, industry, education and science.

The GOP delegates also approved promises to step up the nation's military effort, including "revitalizing" research and development programs needed for advanced new weapons systems, both strategic and tactical.

At the same time, the convention pledged a reduction of "not less than $5 billion in the present level of Federal spending" and promised a balanced budget.

● **Space**—In a strongly worded section titled "fiscal irresponsibility," the Republicans labeled the Moon program an example of a "needlessly expensive crash program." The party said that this was causing neglect of other critical needs, such as health, air and water pollution, and urban crowding.

● **Continued attack**—The platform reiterated charges against Secretary of Defense Robert S. McNamara's defense policies, which have been the subject of a running debate between DOD and GOP Congressmen. Platform committee chairman Rep. Melvin R. Laird (R-Wis.), in fact, began the exchange earlier this year during DOD appropriations debate on the House floor, when he charged that McNamara has been neglecting the development of new weapons systems (M/R, April 27, p. 17). Other Republican Congressmen joined Laird in a lambast of defense policies in a report by the partisan "Task Force on American Strategy and Strength" early this month (M/R, July 6, p. 18).

To these attacks, McNamara replied that during the current Administration DOD has inaugurated 208 new projects, including 77 weapons programs costing more than $10 million apiece, and has increased total R&D funds 50% per year over those prevailing during the last four years of the previous administration.

● **Platform wording**—The GOP claimed that the Administration has "delayed" R&D in advanced weapons systems, and "thus confronted the American people with the fearsome possibility" that Soviet advances might surpass the American lead in the 1970's. It also charged that a "misuse" of cost effectiveness has "stifled the creativity of the nation's military, scientific and industrial communities."

Once again the GOP said there have been no new major strategic weapons systems under McNamara. It said that the Administration has "concealed a lack of qualitative advance for the 1970's by speaking of a quantitative strength which by then will be obsolete."

Defense against ballistic missiles and military development for near and outer space were cited as other areas in which the Administration has lagged.

● **Undermining morale**—The Republicans advocated a strengthening of the stature of top military men, such as the Joint Chiefs of Staff, as the President's principal military advisers.

The Administration was charged with weakening the bonds of confidence and understanding between civilian leaders and military professionals. "It has bypassed professional judgment on major weapons, and equipment in vital national security policy decisions," the document says.

Nonmilitary considerations, the group indicated, have reversed professional judgment "on major weapons, and equipment such as the controversial TFX, the X-22 and the nuclear carrier."

● **Other**—In other sections affecting the missile/space community, the GOP platform promised:

—Never to unilaterally disarm America, and to demand that any arms-reduction plan guarantee reliable inspection.

—To take every step necessary to carry forward the "vital" military research and development programs—including antisubmarine warfare, astronautics and aeronautics, special guerrilla forces and such other defense systems required to keep America ready for any threat.

—To fully implement such safeguards as necessary under the limited nuclear test ban treaty, including advanced tests in permissible areas, and to maintain facilities to test elsewhere in case of violations.

—To regularly review the status of nuclear weaponry under the limited nuclear test ban "to assure this nation's protection."

—To end "second-best weapons policies," eliminating "false economies which place price ahead of the performance."

—A complete reorganization of the National Labor Relations Board to assure impartial protection of the rights of the public, employees and employers, "ending the defiance of Congress by the present board."

—Restoration of collective-bargaining responsibility to labor and management, minimizing third-party intervention and preventing any agency of Government from becoming an advocate for any economic interest.

—Gradual reductions in overseas United States forces as manpower can be replaced by increased firepower.

—A continued re-examination and reduction of Government competition with private business, consistent with the recommendations of the second Hoover Commission.

—A "drastic" reduction in burdensome Federal paper work. ■

Kock directorship confirmed . . .

Site of ERC To Be Announced Shortly

THE FINAL SITE SURVEY for the new Electronics Research Center has been submitted to NASA Administrator James E. Webb.

An announcement of the favored site for the construction of the multi-million-dollar research facility is expected in 10 days to two weeks. While no official comment can be obtained, there are reports that a Cambridge, Mass., site is favored.

At almost the same time that the site selection committee was contemplating its work, the space agency announced the appointment of Dr. Winston Edward Kock, vice president-research at the Bendix Corp., Detroit, as the director of ERC.

His appointment is effective Sept. 1, the same day that a 20-man task force will move into the Boston area to begin the center's work. The task force will be joined by 60 persons from NASA's Northeastern Operations office, which will be absorbed by ERC.

ERC will be directly responsible for basic studies and component-technique investigations in the fields of communications, data processing, navigation, instrumentation and guidance and control.

Current plans call for a staff of about 250 by the end of Fiscal 1965. About 100 are expected to be professional personnel. By 1970, the total staff will hit 2,100, with about 300 professional people and another 900 in the technical supporting personnel category. Recruiting of personnel is just beginning.

● **Broad experience**—Kock joins NASA after eight years with Bendix, where he began as chief scientist of the Systems Division. He contributed to the development of the microwave lenses which are used in Bell System's transcontinental relay link and development of an antisubmarine detection system for which he received the Navy's Distinguished Public Service Medal.

Born Dec. 5, 1909, in Cincinnati, he received a bachelor's degree in electrical engineering in 1932 and a master's degree in physics in 1933, both at the University of Cincinnati. Kock earned his PhD. in physics at the University of Berlin in 1934.

His post-doctoral work has been done at the Institute of Advanced Studies, Princeton, and the Indian Institute of Science, Bangalore, India. In 1936 he became director of Electronics research at the Baldwin Piano Co., where he subsequently developed the Baldwin electronic organ. While with the Bell Telephone Laboratories, he headed the group developing the Picture-Phone, a device now going into service which transmits a picture as well as sound over telephone circuits. ■



Hercules-ABL Quench-Tests Antares Motors

THREE SUCCESSFUL full-scale quench tests have been conducted to date on 29-in. modified Antares motors in a program aimed at developing stop-start technology for solid rockets at the Allegany Ballistics Laboratory of Hercules Powder Co. in Cumberland, Md.

Hercules researchers achieved instantaneous motor shut-off and pressure decay within 0.015 sec., using a water quench approach with associated plumbing. The series of photos above are from sections of a 2,000 frame/sec. record of a typical quench sequence with the large motor.

The first frame shows normal burning. Quench is started in the second frame, and pictures three and four show the immediate reaction. The fifth frame, taken about 15 milliseconds after quench, shows thrust practically terminated. The last shot shows only reflected heat from the motor interior. After each quenching, the motor was restarted for additional tests.

In space operation, a gas generator would be used to pressurize a water reservoir on signal. The water passes into a distribution system which brings it in contact with the burning propellant.

At space vacuum, the water evaporates quickly, leaving the rocket ready for re-ignition. Hercules experts estimate that less than three gallons of water will quench 2,500 lbs. of propellant in a reliable manner.

The tests used flightweight hardware and motors in simulated operational conditions. The system will provide stop-start ability for solid motors used in space maneuvering, mid-course guidance changes, and other potential applications where restart functions are necessary. The research program is being funded by NASA.

First TAD Set to Launch NASA's Syncom III Satellite in Mid-August

Repair of damaged facility clears way after planned June launch delayed by OSO accident; suspect S-258 third stage cleared

by Chris Butler

CAPE KENNEDY—Refurbishment of spin-test facilities here has cleared the way for launching the first *TAD* (*Thrust Augmented Delta*) with the *Syncom III* satellite about Aug. 18.

The spin-test facility was severely damaged April 14 when an X-248 ABL third stage of a *Delta* rocket exploded, killing three men and injuring several others. The mishap also severely damaged an *Orbiting Solar Observatory* spacecraft and cancelled a scheduled June launch of *Syncom III*.

Goddard Launch Operations spokesmen here said a review of preliminary reports by a fact-finding committee studying the April mishap indicates the X-248 problem is not shared by the X-258 third stage, which is to place *Syncom III* in a synchronous, equatorial orbit.

● **Hardware arrival schedule**—The *Syncom* spacecraft is due to arrive here late this month for mating with the third stage and a series of spin and balance tests.

The third stage and payload are scehduled to be mated with the first two stages about five or six days before launch.

The *TAD*, which employs a *Thrust Augmented Thor* for a first stage, already is on hand and is being checked out by NASA and Douglas Aircraft Co. engineers and technicians. The first two stages will be placed on the launch stand of Complex 17-A in the last week of July.

The launch stand and service structure on 17-A were extensively modified early this year to accept the *TAD* and its three strap-on XM-33 solid rockets. The pedestal ring was raised about five ft. and work platforms were cut to accommodate the solid rockets.

Despite the launch stand modifications, 17-A will handle *Thor* and *Thor-Delta* configurations as well as the *TAD*, making it one of the most versatile launch stands on the Cape.

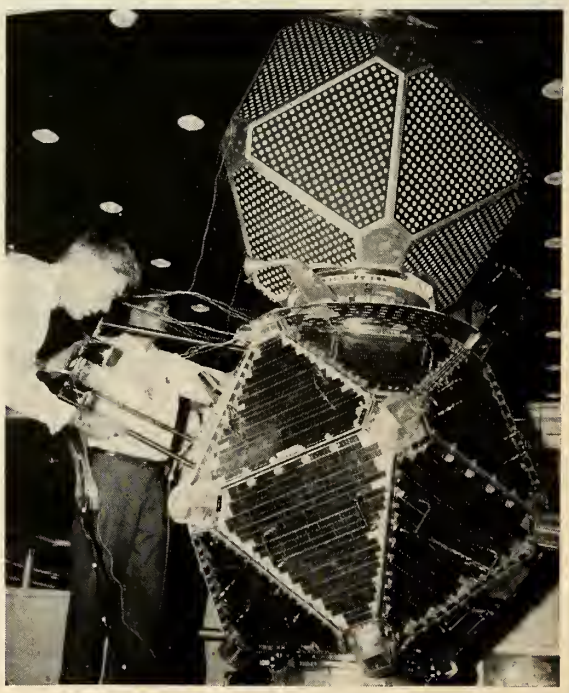
● **Olympics coverage**—If the August launch and the spacecraft operation are completely successful, *Syncom III* will be on station in time to transmit television pictures of the Olympics from Japan to the United States. The spacecraft is due to be placed in a synchronous orbit over the intersection of the equator and the International Date Line.

Principal changes in the spacecraft consist of minor electronic modifications to improve TV transmission and use of two peroxide systems for stabilization and positioning. *Syncom II* utilized one peroxide and one compressed nitrogen system for control after reaching orbital position.

A prototype model of *Syncom III* is now on hand here and Goddard spokesmen say it could be modified for use as a backup if *Syncom III* fails to perform as expected, but added that such a move would require high-level authorization for a crash program to prepare and launch the spacecraft. As the program now stands, the currently scheduled launch will end the *Syncom* project. ■

NDS

NUCLEAR DETECTION SATELLITES are checked out in tandem position prior to scheduled launch last week from Cape Kennedy. Improved instrumentation is expected to yield better results than those attained with first satellites launched last October.



Wall Street Expert Sees Steady Level Of Spending But Warns of Profit Drop

Government action called for to prevent evolution of 'profitless industry'; Sprague views expanding electronics market in '70's

by Michael Getler

NEW YORK—High-level spending in the missile/space industry is likely to continue, but there is danger that it may become "a profitless industry which may ultimately end up as an extension of the Federal Government."

This view was presented at the recent meeting of the American Management Association here by Peter Slusser, an aerospace securities specialist from the Wall Street firm of Shields & Co.

Slusser said recent data indicated that the space-defense budget in 1970 will continue to approximate 55% of total Federal expenditures—about $61-70 billion in terms of 1963 dollars.

This estimate exceeds Dept. of Defense projections, Slusser noted, but he added that "post-World War II history has proven that most estimates of defense spending have been on the low side, and have frequently been upset to the high side by acts of our major international competitors, the Communists."

There is increasing concentration of procurements within a hard core of big contractors, he observed, and it appears that the industry may eventually be dominated by a few firms, much as the automobile industry is today. Further, there seems to be a concentration within the concentration, in companies such as North American Aviation, McDonnell Aircraft and Lockheed continue to grow, while Douglas, Republic, Curtiss-Wright and Fairchild Stratos, among others, may be declining. "It seems to us," Slusser asserted, "that this concentration ratio will probably continue among the larger companies."

The "middle-sized" contractor, especially the less proprietary subcontractor, is being squeezed both in profits on individual jobs and in total business available. Small businessmen who have highly proprietary products or know-how undoubtedly will continue to prosper, Slusser said, but they must expect keen competition and a constant threat of technological obsolescence.

● **Electronics cushioned**—The Electronics industry can look forward to an expanding market despite a reduced rate of military spending in comparison to the trend of the past decade, a company official predicted.

Robert C. Sprague, chairman of Sprague Electric Co., North Adams, Mass., told the AMA a combination of an increased share of overall defense spending and major growth in non-military government and industrial-consumer markets should lead to an annual sales figure of $24.8 billion by 1973—up from $14.8 billion in 1963.

He said it was reasonable to anticipate a drop in annual defense spending from the current $51-billion rate to under $47 billion between now and 1968. But the electronics share of the defense budget is expected to increase with technological advances. The electronic content of DOD expenditures will climb from 16% this fiscal year to more than 18% by FY 1973, he forecast, and military electronics should remain stable between now and 1968—rising slightly at a rate of 1.1%—despite reduced defense spending.

"It is not unreasonable," Sprague declared, "to assume that there may be a reversal in the trend of reduced spending by the late 1960's and early '70's, as technology continues to advance and new concepts of what is essential to our national security come to the fore." He estimated a total military electronics market of approaching $10 billion by 1973, some $2 billion more than the current rate. "Clearly," he said, "this is a fact of life the electronics industry can live with."

● **Trend attacked**—Slusser noted in his address that net profits after taxes in the defense industry appear to be in a continually declining pattern, currently at a level of about 1.5% on sales for 51 aerospace companies. This compares to about 5% of sales for all U.S. manufacturing companies.

The aggregate trend in contractor profits probably will continue to decline, he said, due to a number of factors. He listed a rate of increase in industry facilities and capabilities which outstrips available business in many areas, an accompanying shrinkage of business in some other areas, development of ceilings on incentive contracts which will not balance out overall losses on projects, and increases in disallowed costs.

Slusser strongly urged that government policy should allow and encourage high profits in the defense industry. "If something is not done to reverse this trend toward unprofitability," he declared, "citizens, contractors, and the government may in due course find that defense costs are inexplicably going up while weapons performance somehow goes down."

Discussing the defense company as an investment, Slusser noted that although there is some expectation that aggregate profits could improve from the reduced 1963 levels, this remains to be seen. Ironically, many investors now look upon defense companies as yield situations only, and expect very little if any growth or appreciation. ■

Technical Countdown

PROPULSION

Navy to Have Underwater Test Stand

An underwater rocket-thrust test stand—possibly the first ever seriously contemplated—will be designed and constructed for the Navy by the Allegany Instrument Co. The 2,500-lb.-thrust-capacity stand, to be installed at the Naval Ordnance Laboratories, Silver Spring, Md., facility will permit static thrust measurements to within ±0.006% at simulated water depths, the firm claims. Motors will be submerged under roughly 5 ft. of water, and greater depths will be simulated in the closed container hydrostatically.

Hydrazine Gas Generator to Be Built

Rocket Research Corp. of Seattle will manufacture a gas generator using liquid hydrazine as the fuel under a Navy contract. The hydrazine will be pumped through a catalyst bed, decomposing into nitrogen, hydrogen and ammonia gas at high pressure. The catalyst is the result of work by Shell Development Co. funded by NASA's Liquid Rocket Technology Program. The gas produced will be cool and clean in contrast to conventional gas generators. The catalyst makes possible a new degree of starting ease and allows multiple restarts without difficulty, say company spokesmen. The generator will be used by the Navy in several missile and electrical power generation applications.

Hybrids To Be Component Test Units

United Technology Center will deliver two hybrid rocket systems to NASA's Marshall Space Flight Center under a $200,000 contract. The units will be the most powerful hybrids yet fired, but both will be used to test solid rocket components such as nozzles and hot gas valves. The hybrid gas generators will use a 36-in.-dia. grain of rubber and aluminum with LOX as the oxidizer. With exhaust characteristics almost identical to those of a sold system, the re-usable hybrids will deliver flows equal to a 25,000-lb.-thrust rocket.

ELECTRONICS

Westinghouse Completes Lunar Power Study

A nuclear power system designed to fit the *Saturn V* payload shape and weight restrictions and capable of generating over 100 kilowatts of electricity for a lunar base is out of the study phase at Westinghouse Electric Corp.'s Astronuclear Lab. The power plant was also included in a model display of units that might form part of a manned lunar exploration base. The firm is also studying an integrated lunar power system, which includes the nuclear plant and a complex of auxiliary power supply units under contracts with the Army Corps of Engineers. The plan envisions fuel regeneration units to recover hydrogen and oxygen used in fuel cells to power roving vehicles and other applications. The nuclear power plant would provide electricity for the regeneration from the water produced by fuel cells.

Closed-Cycle MPD Generator Hits 1.57 Watts

An output of 1.57 watts has been achieved by Martin/Baltimore scientists using a low-temperature, closed-cycle magnetoplasmadynamic generator. In experiments at the firm's nuclear division, helium gas heated to 1,300°F, seeded with cesium and pre-ionized by an electric arc is shot past the poles of a 29,000-guass magnet. A practical MPD generator would use a nuclear heat source. Martin experts say the 1,300°F temperature is well below that needed to obtain good electrical conductivities in other systems.

MATERIALS

Continuous Carbon Yarns in Production

A continuous process in operation at the Carbon Products Division of Union Carbide Corp., Fostoria, Ohio, is turning out refractory carbon yarns approaching the strength-to-weight ratios of general purpose glass filaments at room temperatures. The carbon yarns retain or increase their strength past 5,000°F until sublimating at about 6,600°F. The process is adaptable to the production of yarns ranging from 50 to 10,000,000 ohms/ft., but initial runs will be confined to the 90 to 300-ohm/ft. range. Average breaking strength of the 5 ply, 2,100-yd./lb. yarn is 16 lbs. First major use is expected to be in electric resistance heating elements.

Glass Laminates for Pressure Structures

Scientists at the IIT Research Institute are bonding layers of flexible, extra-thin sheets of glass through a proprietary adhesive into thin glass armor applicable to space structures and deep diving submarine hulls. IITRI experts have laminated 50 layers of 0.002-in.-thick glass sheets without apparent loss of transparency. Both curved and flat shapes are possible. Rings and cylinders for deep-submarine hulls have been fabricated.

CF_3NO_2 Valence Force Field Calculated

The fully fluorinated nitromolecule, CF_3NO_2 and its vibrational spectrum were the subjects of a valence force field calculation by Alex Castelli of the Army's Picatinny Arsenal. Vibration frequencies, potential energy constants, geometries and electronegativities of the fluorine molecule, as well as other nitromolecules, CCl_3NO_2 and CBR_3NO_2, were described by Castelli and others at a recent spectroscopy symposium. The calculation was made on an IBM-709 computer and generalized to be applicable to many boron as well as amine molecules of various structures.

SPACE MEDICINE

Astronaut Dehydration Studies Progress

Experiments by AiResearch Co., results of which tend to refute the long-held belief that the human exhales the same amount of water vapor regardless of pressure altitude, work load, temperature of humidity, may help solve the problem of astronaut dehydration uncovered in Project *Mercury*. The work, done under a $20,000 contract from USAF Aerospace Medical Division, shows that exhaled breath is not always at body temperature and vapor-saturated. It will be several weeks more before consistent relationships between breath humidity and temperature and cabin atmosphere variables can be determined. The knowledge will permit more exact setting of space cabin dewpoint to minimize dehydration of the occupants and also may affect the design of future spacecraft water removal systems.



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Apollo Unified S-Band Network To Cost Minimum of $160-170 Million

Expected further requirements for ground and ship stations could push outlay over $200 million; details of planned system

by Charles D. LaFond

NASA and the Dept. of Defense already plan to spend $160-170 million for the *Apollo* Unified S-Band Network. The global tracking and communications network will support all the orbital and lunar exploration missions now planned.

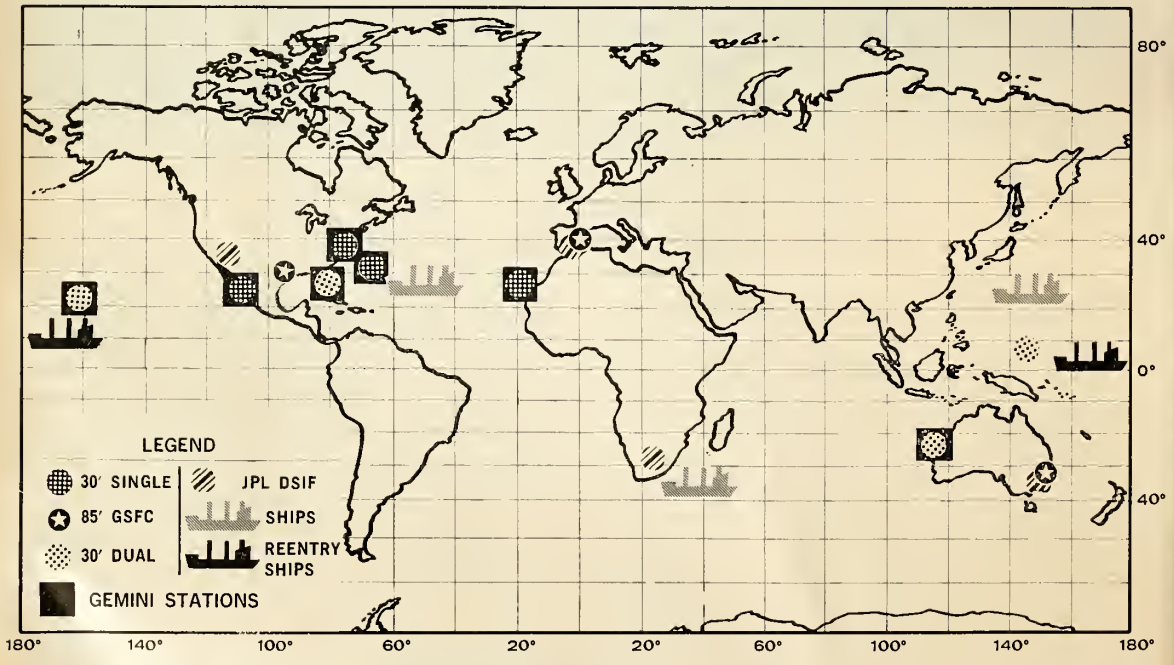
The ground and range-ship stations presently projected are considered minimal. If more are required, as anticipated by industry informants, the program could easily require expenditures in excess of $200 million during the next three to four years.

The new NASA Unified S-Band Network will provide a single global system capable of providing the *Apollo* missions with a means for precision tracking and two-way voice and data communications. The tracking phase will employ a Jet Propulsion Laboratory-developed Range and Range Rate system. The latter uses a coherent Doppler and pseudo-random range system design to provide range, range rate, and angle measurements.

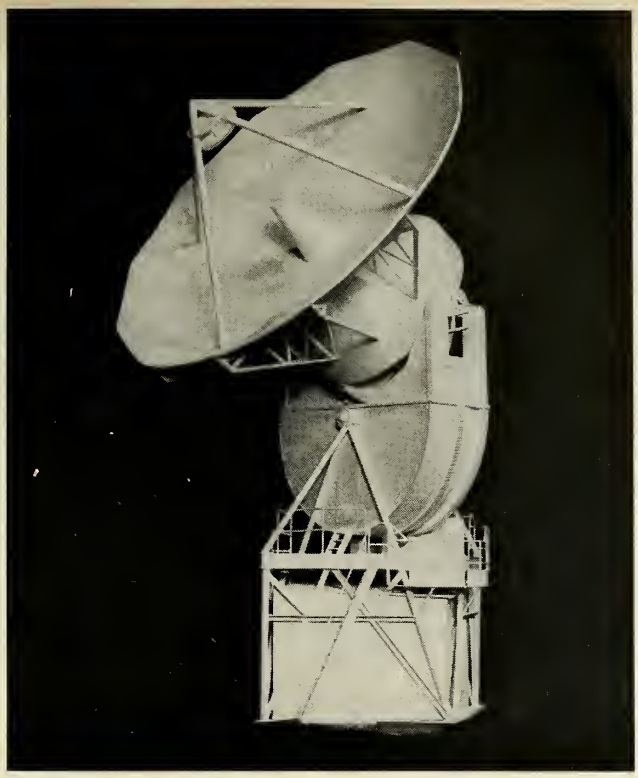
The overall system, including antenna sizes, represents a carefully explored technical compromise to best use the greatest number of existing facilities (and their equipment), to secure the best frequencies considering spectrum congestion and attenuation tradeoffs, and to hold the spacecraft subsystems to the minimum required commensurate with meeting mission safety and performance needs.

Under a recently awarded $22-million contract from NASA's Goddard Space Flight Center, Collins Radio Co.'s Dallas division will provide the bulk of the Unified S-Band ground electronic subsystems, 30-ft. antennas and collimation towers, and common electronic ground equipment for the S-band 85-ft. antenna stations. Blaw-Knox is currently building three 85-ft. dishes for Goddard under a separate contract.

● **Land stations**—Three types of stations will be employed: a 30-ft.-dia. dish with one complete S-band system for *Apollo* Command Module support;



UNIFIED S-BAND Network now conceived will include up to 13 ground stations plus five ships. Ground sites include (l. to r.) Hawaii; Guaymas, Mex.; Texas; Cape Kennedy; Wallops Is.; Bermuda; Canaries; Madrid; Carnarvon; Canberra; and Guam.



30-FT.-DIA. X-Y, S-Band antenna will employ Cassegrain feed and carry own 3-ft.-dia. acquisition antenna. Collins has contract for nine.

a duplexed 30-ft.-dia. dish with dual S-band facilities for Command Module and Lunar Excursion Module support; and an 85-ft.-dia. dish with one S-band system for lunar-range *Apollo* support.

Thirty-foot antenna/single S-band stations will be located at Guaymas, Mexico; Wallops Island, Va.; Bermuda; and the Canary Islands. Thirty-foot antenna/dual S-band stations will be installed at Hawaii; Merritt Island (Cape Kennedy), Fla.; Carnarvon, Australia; and Guam. The three Goddard 85-ft. dish facilities will be located at Canberra, Australia; Madrid, Spain; and at a site not yet announced in central Texas (See accompanying map.)

First station installations will be accomplished at Bermuda, Wallops Island, and Carnarvon—probably in that order.

Negotiations are under way for two more island stations. The equipment for one of these will be set up temporarily by Collins at its Dallas, Tex., antenna test facility for developmental testing.

The three existing 85-ft. antenna Deep Space Instrumentation Facilities, operated by JPL at Goldstone, Calif., Canberra, Australia, and Johannesburg, South Africa, plus the new DSIF station near Madrid, Spain, will be used, if necessary, as backup to the Goddard 85-ft. dish facilities. (S-band electronic subsystems for these stations will be procured under a separate contract, according to NASA officials.)

● **Five ships planned**—Approximately $133 million will be spent during the next several years for five instrumentation ships to support the Manned Spacecraft Network.

The venture will be directed by a joint Navy-Air Force-NASA team operating out of a special group set up by the Navy—the Instrumentation Ships Project Office (ISPO), headquartered in Washington. The conversion program will be handled in two phases under separate funding and probably by two different prime contractors.

Fiscal 1964 authorizations for the first three vessels, designed for the Insertion and Injection phases of the *Apollo* mission, are $83.3 million for NASA and $14.5 million for DOD.

A Methods and Management Proposal review by the ISPO has resulted in reducing the number of qualified bidders to eleven. These, said Robert McCaffrey, NASA deputy director at ISPO, are now preparing firm bids due in by Aug. 24 for a fixed-price contract.

Under the present schedule, McCaffrey disclosed, the first completed instrumentation ship should be ready at the shipyard by January, 1966. The first vessel is scheduled to be mission-ready by July, 1966, and the other two by January, 1967.

Three T2 tankers will be required for the conversion. These will undergo massive surgery, with the entire tankage sections removed and replaced with new sections designed for instrumentation and quarters. Ballast and possibly stabilization systems will also be added.

Two ships will be equipped as 30-ft. antenna/dual S-band stations and one as a single S-band station.

● **Re-entry ships**—Funds for the remaining two vessels have been requested for Fiscal 1965: $28 million for NASA, $7 million for DOD. Two existing Pacific Missile Range ships, the Huntsville and the Watertown, will be modified, McCaffrey said. Both are World War II Victory ships.

To be used for the re-entry phase of the *Apollo* missions, these vessels will not require extensive changes. They will be provided with C-band radars as well as S-band, but the latter systems will employ smaller antennas than the insertion and injection ships and will have only a single-channel capability.

Both are scheduled to be mission-ready by early 1967, McCaffrey said.

Technical personnel for all five vessels will be trained, depending on their respective assignments, at Wallops Island, Atlantic Missile Range or the various equipment suppliers' facilities.

● **Collins' role**—Following a final competitive negotiation (with a once broad field narrowed to Collins and Philco Division of Ford Motor Co.), Collins was selected by NASA to design, develop, manufacture, install and check out a major portion of the systems for the Unified S-Band System. First sign off was made on June 29 by Collins; NASA is expected to formalize the contract shortly. Twelve months thereafter, Collins, under a fixed-price/incentive contract, is scheduled to deliver the first complete system.

Nine stations, employing 30-ft.-dia. paraboloidal reflector antennas, are called for, including four single stations and five dual stations. In addition, Collins will provide *Apollo*-unique electronics for the five range ships and the three Goddard 85-ft. dish stations.

The contract includes a NASA option for three additional stations.

Thirty-foot antennas will be designed to include a 3-ft.-dia. acquisition antenna that will direct the larger antenna's 1-degree beam to the distant target. The large dish will employ a Cassegrain feed.

Other station major equipments will include a diplexer, parametric amplifier (2,300 mc) converter system, 10-kw S-band power amplifier, tracking data processor system, collimation tower and equipment, a 2,300-mc boresite source, timing system, and a PCM signal conditioner and calibrator. ■

Apollo Astronauts Are Painstakingly Protected From Solar-Flare Protons

Precautions meet requirement of 99.5% probability of mission success; a detailed report on shielding and detection plans

by Rex Pay

CLEAR LAKE, TEX.—*Apollo* astronauts will be protected from proton radiation from solar flares chiefly by spacecraft design and by precalculated flight maneuvers. These have been optimized in accordance with the statistics of solar proton storms to yield the required overall probability of mission success of 99.5%.

NASA ground equipment around the world will monitor solar activity continuously on a 24-hour basis. One half-hour after a flare is observed a prediction of expected proton intensity in 12 hours time will be available. If high intensity is predicted, an astronaut on the Moon will have time to return to the safety of the orbiting Command Module.

Air Force and Central Radio Propagation Laboratory equipment monitoring activity in the Van Allen belt will assess any hazard posed by illegal weapons testing in that region.

● **Limits set**—J. Eggleston, Assistant Chief, Space Environment Division, at the Manned Spacecraft Center here, said spacecraft shielding has been evaluated on a 14-day mission basis with an emergency limit on the maximum radiation dose to the skin set at 500 rads. The maximum permissible skin dose governs both shielding design and in-flight operations, because this limit is reached before that set for the blood-forming organs, 200 rads.

The dose limit set for the eyes is 100 rads, but this does not influence spacecraft design or inflight maneuvers because eye protection is easily obtained with a simple visor.

These radiation figures are emergency numbers. The nominal design limits on which designs are based are roughly one half of these. An astronaut exposed to the nominal radiation dose would experience no radiation reaction, but some effects might be discernible by clinical examination after his return to Earth.

Exposure to the emergency limit dose would have no effect on the probability of mission success, but the astronaut would have a mild case of radiation sickness on return to Earth. He would also be barred from flying further space missions.

Hardware and mission design has in fact had to meet two independent requirements. The first is the requirement to meet the conditions of a normal mission, that is to design to the nominal dose. The second is to provide a 99.5% probability of not exceeding the emergency dose limits. Statistical analysis of proton events in the past has produced a figure for the probability of a high proton event on which this design requirement is based. These events are about 100 times the intensity of a nominal solar proton event.

● **Proton peril**—Bursts of protons from solar flares are the most dangerous of the radiation hazards in space. Cosmic rays reach the Earth-Moon system at relatively low intensities, although they have high energies. During the *Apollo* mission the cosmic ray dose will be 30 millirads, which is the same as that received by Astronaut Gordon Cooper on the *MA-9* flight.

Van Allen radiation is also a relatively low hazard because of the spacecraft's rapid passage through this region. The dose from trapped radiation in these belts is only one tenth of the allowable limits for typical lunar trajectories.

The ejection of protons from solar flares usually takes place in association with sunspots or groups of sunspots. Not all flares eject protons and not all proton showers reach the Earth-Moon system. Their arrival here depends on their direction of ejection and the magnetic fields they encounter as they travel outwards in the solar system.

Simple visual detection of a flare is not enough to decide that proton radiation can be expected. This is why the new NASA solar monitoring system is being installed.

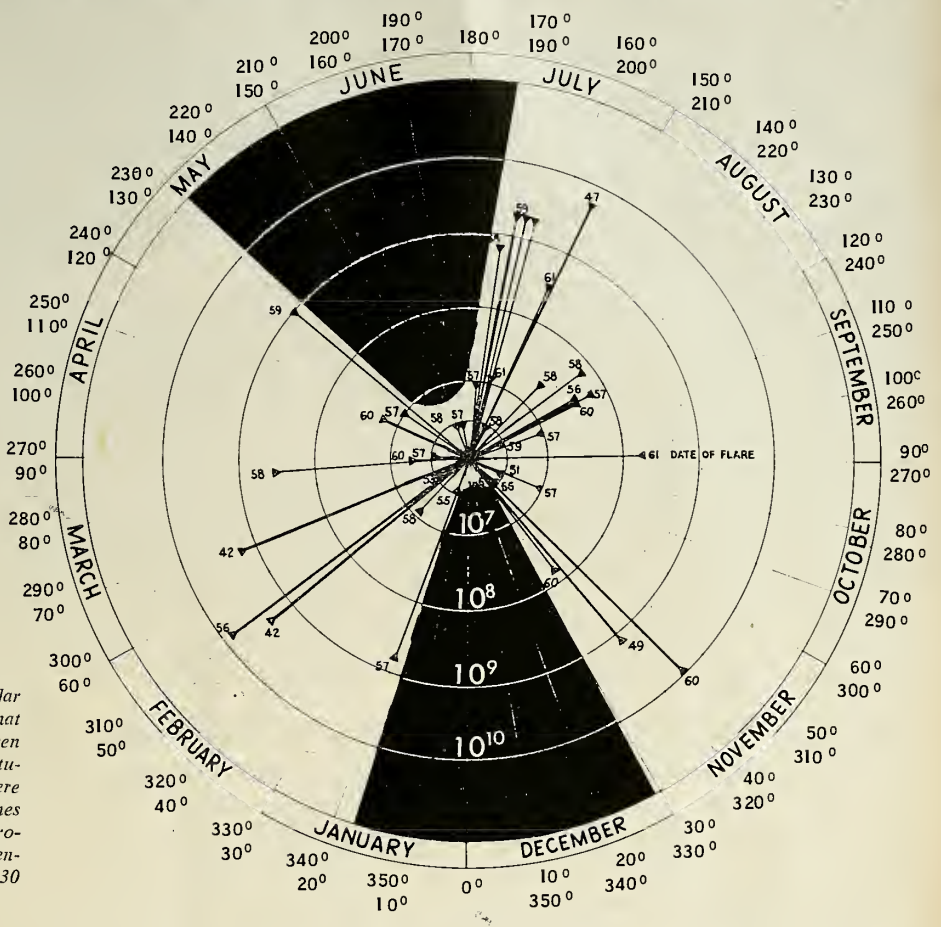
● **Module protected**—Using the measured intensity and duration of solar flare proton events during the years 1956-61, MSC analyzed *Apollo* Command Module shielding to insure that the astronauts would receive the specified emergency dose on less than one mission in a thousand. The basic structure and onboard equipment does give this protection, provided a transparent visor protects the astronauts' eyes.

If the *Apollo* spacecraft, as it is now designed, were exposed to the largest solar proton dose recorded in the last solar cycle, the astronauts would be exposed to only one-ninth of the critical dose designated from the mission. Even the sequence of three flares observed in 1959 would not have exceeded the emergency dose in the Command Module.

Protons must have a minimum energy of 36 Mev to penetrate the Module. To provide a conservative assessment, however, protons with energies of 30 Mev were used as a basis for the shielding calculations.

Onboard radiation monitoring equipment has been selected on the basis that there should be none that an astronaut cannot interpret and act on. For example, solar-flare monitoring equipment of the type deployed at ground tracking stations is not included. Each astronaut will have one or two personal dosimeters that record accumulated

TOTAL FLUX PER EVENT VERSUS DATE



PAST HISTORY of solar proton storms shows that certain months have been free of hazards. Unfortunately, this may be mere coincidence. Radial lines indicate number of protons per sq. cm with energy greater than 30 Mev.

dose. The wrist watch type probably will be used. He can read this meter and report the dose back to Earth over the voice communications link.

Each astronaut will also carry film badges that will be used for medical records when he returns to Earth.

A portable survey meter of the type reading dose rate will be carried in the Command Module. This will give a quick means of finding out those regions of the spacecraft where a lot of radiation is coming in. It can also be used on the surface of the Moon.

● **Spectrometer**—The proton and alpha flux outside the spacecraft will be measured by a particle spectrometer. This will indicate whether it is safe to go outside the spacecraft. RFP's for this instrument are likely to be released shortly by North American Aviation.

The sensor for the particle spectrometer will be located on the Service Module. The protruding device cannot be accommodated on the smooth skin of the Command Module. The spectrometer will record alpha fluxes at four energy levels and proton fluxes at four levels. In big events, alpha particles might account for ⅓ of total dose, but in small and medium-size events the contribution of alpha particles is insignificant.

Early *Apollo* Earth-orbital flights will be used to check out the performance of the onboard equipment. One question that is to be answered is the possibility of damage to the detectors in the Van Allen belts, said J. Modisette, MSC manager for onboard radiation monitoring systems. He suggested that there is a strong possibility of improvement of sensors before the first *Apollo* flights, particularly in the area of solid-state devices.

There is also the likelihood that other radiation monitoring equipment may be carried for use in scientific experiments.

● **Peak hazard**—The radiation threat of solar protons varies of course during different parts of the *Apollo* mission. The astronaut is most exposed on the surface of the Moon, where he has only his spacesuit as a shield. The Lunar Excursion Module itself also gives very light shielding. On the lunar surface an astronaut receives about 10 times the dose he would experience when in the Command Module.

On the lunar surface, a solar proton event of a few hours might put the astronaut beyond the specified dose limits. If this appears likely he must return to the Command Module.

At present MSC is evaluating the personal dose limits that will govern the decision to return. There are in fact two steps in the decision process. The first is to determine the point at which the astronaut must return to the LEM and start the countdown. The second is the point at which the decision to leave the lunar surface is made. If the flux decreased after the start of the LEM countdown, the return to the Command Module could be canceled.

The decision to return to the orbit-



The Gemini/Agena rendezvous: **Docking is a dual job**

As it flashes through space, NASA's two-man Gemini spacecraft is scheduled to meet and mate with its in-flight propulsion source — the dependable Agena space vehicle designed, developed, and built by Lockheed. Here's the program for this history-making flight: ■ Within five days after Agena is launched and placed into exact orbit, Gemini will be boosted into space. The astronauts will then correct their orbit to match that of Agena, rocket ahead and couple up. Sounds simple — but maneuvering at tremendous speed in the hostile environment of limitless outer space requires extraordinary precision from both men and machines. ■ Agena provides the muscle for the mission. Its multistart engine and control systems respond instantly on command to change orbit, slow down, speed up, even lap Gemini, to accomplish the rendezvous. The stabilizing system performs the delicate job of holding Agena completely steady during the docking process. Finally, after docking, Agena has the capability to power the spacecraft in extensive maneuvers. ■ In test after test — more than 120 launches to date for both NASA and the Air Force — Agena has proved its reliability. It makes an ideal partner for the Gemini meet-in-space series. Lockheed Missiles & Space Company, Sunnyvale, California: A Group Division of Lockheed Aircraft Corporation.

Lockheed

See the Agena in the U.S. Space Park at the New York World's Fair



ing Command Module would be based on the proton intensity predicted by Earth-based instrumentation. Account would be taken of the radiation dose received on the way to the Moon, as indicated by the astronaut's personal dosimeter.

MSC considers that an astronaut will have to wait no longer than two hours on the Moon for the correct launch opportunity to rendezvous with the Command Module. About one hour of this time would be taken up with warming up the LEM systems.

There will be no modification to the LEM launch trajectory in the event of a solar proton storm. If the LEM is at an equatorial landing site it will probably rendezvous with a direct Hohmann transfer, meeting the Command Module 180 degrees around the Moon. If the LEM is not at an equitorial landing site, the rendezvous might occur at 135 degrees around the Moon, with a plane change being made at the same time that the LEM is inserted into lunar orbit.

● **In orbit**—Best protection for the astronauts is when they are in the Command Module in lunar orbit. If a single flare occurs at this time in the mission there is little point in returning to the Earth—it will be a three-day journey and most of the dose will have been received by the time a landing is made.

However, if there is a strong likelihood of a series of flares, it may be advisable to abort from the translunar phase and return to Earth.

Proton storms vary in their directional characteristics. In some, many of the protons come from roughly the same direction and the Moon will cast a shadow. The actual reduction in proton flux amounts to about 20%.

Precise figures cannot be given because the reduction depends on the directional distribution of the proton flux.

When traveling between the Earth and the Moon a similar reduction of about 20% can be gained in the Command Module by pointing the Service Module in the direction of maximum proton flux.

When in orbit around the Moon, the procedure will be to point the thinly shielded part of the Command Module toward the Moon.

Other measures that can be taken are to stack movable equipment where it can be more effective as a shield, and for the astronauts to change places with each other at regular intervals so that each receives the same dose.

Studies of the shielding made by rearranging the position of movable stores, such as lithium hydroxide canisters and water, show that a 20% dose reduction is possible, said Modisette.

He pointed out that rearrangement of on-board equipment could go beyond this with the unbolting of black boxes and their rearrangement as a radiation shield. This would only be called for in the event of an extremely intense storm of protons, with a probability of one in 10,000 or less. Studies are in hand to evaluate the tradeoff between the value of gaining increased radiation protection in this way and the danger of damaging equipment.

● **Monitoring**—The main ground observation system for monitoring the solar proton hazard will consist of seven optical and three radio telescopes located at *Apollo* S-band tracking stations around the world (see p. 18) and three forward-scatter radio links in North America. The optical telescopes will be located to provide good 360° coverage and to take account of the probabilities of cloud cover. They and the radio telescopes will track the Sun.

The radio telescopes, to go in at DSIF stations, measure Type 4 radio noise. One in every three Type 4 radio noise bursts corresponds to a proton flare that reaches the Earth-Moon system. The forward-scatter links indicate the arrival of protons and their energy distribution. The optical telescopes record the development of solar flares.

The chief difficulty is in assessing the amount of hazard that a proton event indicated by radio noise and a solar flare represents. The intensity of a proton event can vary over four orders of magnitude, and there is not a good correlation between the intensity of the first-arriving protons and the total intensity of the slower traveling particles that arrive later.

In most cases the peak number of particles arrives about one day after the radio noise burst indicates that they have left the Sun. The particles of interest to the *Apollo* mission, however, are those above an energy sufficient to penetrate the Command Module, and these reach their peak intensity in the vicinity of the Earth within half a day.

● **Knowledge gaps**—To discover the significance of the detection of a Type 4 radio burst and a flare, scientists need additional data about the visual range of the solar flare, its location on the Sun's surface, its association with sunspots, its history over the previous week, and the magnetic characteristics of the Sun and interplanetary space. A major task at present is to tie these variables down to a theory, said Eggleston, so that it can be determined precisely what intensity protons from the Sun will reach the Earth.

In general, proton streams spiral out from the Sun. However, disordered areas in the interplanetary magnetic field cause some scattering of the particles. A fairly good quantitative assessment of the hazard from a solar flare observed on the Sun can be reached, but a more precise method would be very useful.

The magnetic structure associated with the Sun is one of the more important factors in deciding whether a proton stream reaches the Earth. It is a slowly varying quantity, which has been studied by a Mount Wilson program for several years. "This is where we look for a major input from existing stations and observatories," said Eggleston.

● **NASA network**—The NASA system of radio and optical telescopes and forward scatter stations is the first to operate on a continuous basis, and the data obtained will be made freely available to scientists investigating solar phenomena.

The forward scatter network in North America is now in operation. Signals transmitted at various frequencies are reflected off the D layer of the ionosphere. A receiving station some 600 mi. from the transmitter picks up a reflected signal directly proportional to the absorption of protons in the D layer. The variation of reflections of the signal with frequency is an indication of the energy spectrum of the arriving protons.

Two forward scatter links are operating in Alaska, between Annette Island and Anchorage, and between Fairbanks and Point Barrow. The third operates on the northeastern side of Canada, between Frobisher Bay and Great Whale River.

Full-frequency range of the stations is between 20 and 50 mc. As the solar cycle proceeds the swept frequency is adjusted. At present, operating frequencies cover 30 to 40 mc.

The optical and radio telescopes are scheduled to be operational by mid-1966.

The optical telescopes will have four-inch objectives and a hydrogen-alpha line filter. A continuous photographic film of the Sun's surface will be obtained at each observing station, providing a record of developments leading up to any particular flare that becomes of active interest. A contract of $240,000 has been awarded to Razdow Laboratories to provide seven of these telescopes.

The radio telescopes will each operate on three frequencies: 1400 mc., 2900 mc., and 4900 mc. The degree of automatic recognition of Type 4 bursts to be incorporated at each telescope has not been decided upon yet. Also, the question of on-site analysis of data with transmission of warnings only, or the transmission of all data to the Manned Spaceflight Control Center, has not been resolved. Airborne Instruments Laboratories Inc. is providing three telescopes under a $255,000 contract. ■

A SPERRY MANAGEMENT REPORT



Checkpoint: 31°- 09"S., 02°- 37"W. With the modern concept of seaborne tracking stations, any point in the ocean envelope becomes a checkpoint for overflying or re-entering spacecraft. The highly successful ARIS (Atlantic Range Instrumentation) ships, produced under Sperry system management, proved the reliability and feasibility of the floating "space laboratory." ARIS involved management of an entire shipyard, for conversion of existing vessels into tracking ships... integration of systems from diverse sources... advanced radar systems... organization techniques to get the job done... and management background such as Sperry had derived from programs like Navy's *Polaris* and Army's *Sergeant*. The Sperry "tracking ship" team today is among the finest available to the nation. **General Offices: Great Neck, New York.**

SPERRY
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Thiokol Motor To Test Paper As Low-Density, High-Strength Laminate

by John F. Judge

ELKTON, MD.—The Elkton Division of the Thiokol Chemical Corp. will soon fire a half-scale Tomahawk research motor—with all the inert parts made of paper.

More than three years of low-key research and development have led to practical use of paper/phenolic laminates in place of metals and reinforced plastics in small, high-performance rockets.

The drive to keep density down while increasing strength has resulted in formulations and engineered configurations with strength-to-density ratios equal or better than those of the high-strength aluminum alloys used for the same purpose—and as good as most steel compositions.

The current paper/phenolic components under test at Elkton have strength-to-density ratios in the 700,000 in. area. A. E. Williams, manager of engineering at the division, says the early work used commercial electronic paper grades, but research has improved to a point where the product strength is tripled while the density remains unchanged.

"The new material is basically the same as that used in the beginning," says Williams, "only the process is different."

● **Orientation is key**—Thiokol will not divulge fabrication details except to say the secret is in knowing how to orient the material. Patent applications have been filed. The major material is paper, coupled with a suitable phenolic, and paper is not known as an oriented engineering material.

Besides the obvious advantage of light weight, there is a tremendous cost savings factor in the paper rocket technology. While the basic materials cost is quite comparable to the aluminum alloys, the fabrication and assembly costs are only 50% to 30% as much—and often less.

There is an inherent quality control advantage in the process, according to Williams, but the Thiokol expert did not elaborate.

● **Home-grown material**—The basic paper/phenolic composition is produced by Thiokol's Panelyte Division in Trenton, N.J. Fabrication of component parts through the proprietary process is also handled at Panelyte. This division has a broad production and research ability in reinforced plastics, laminates and other materials, including complete lines of high-compression molding, tape-winding hydroclaving and X-ray equipment.

There is no compression molding in the current technique. Williams says paper components can be worked like wood. The original fabrication process can result in an almost-finished product—keeping costly machining and other shop effort to a minimum.

The individual components are joined by adhesive bonding. In the 60-odd hot firings to date, there has not been a single bond failure. The only bonding qualification is cleanliness—it should be done with white gloves.

Williams says scale-up is relatively easy and that there are no inherent size limitations. There will be only 50 lbs. of propellant in the subscale Tomahawk firing, but Thiokol can go to 7,000 lbs. in a 31-in. motor diameter without any problems—except funding.

● **Paper description**—The material is a special-grade paper phenolic termed Panelyte 6004 with strength-to-density ratios from 600,000 to 700,000 in. In comparison, aluminum 7075 T-6 is 700,000 in., 4130 steel is 707,000 in. and 18%-Ni Maraging steel is 865,000 in. These are ultimate strengths at room temperature and uniaxial only. The paper phenolic range represents nominal values dependent on the ratio of wall thickness to the inside diameter of the pressure vessel.

Paper components are already in limited use. The adapter forward of the canted nozzle in the *Recruit* rocket is paper phenolic, as are the igniters used in Thiokol's Tomahawk rocket.

An experimental spin rocket was designed for one prime contractor to be included in a proposed missile system. The small spin unit used one tiny metal screen in its center portion. The rest, excluding propellant, is all paper. The screen can also be fabricated from paper. The inert parts before assembly, cost about $4.00. If the spin unit was all metal, total cost before assembly would have been more than $25.00 per rocket. ■



THIOKOL-ELKTON has conducted more than 60 firings of paper component rockets with chamber pressures varying from 400 to 1,300 psi. The large cutaway cylinder above has been used as the basic propellant insulator to test most of the other components visible. The Tomahawk igniter is directly below, just above the spin rocket. Tested jet vanes sections are to the right of the cylinder above a whole blast tube and sections of a blast tube assembly. The supersonic section has the typical bulge.

Canada Poised to Enter Sounding Rocket Market with Black Brants

Canadian Bristol Aerojet expects to develop complete family on schedule; electronics design capability grows rapidly

WINNIPEG, CANADA—A modern solid-propellant processing plant and a rapidly growing in-house electronic capability to back up customer payload requirements mark Canada's first major entry in the world sounding rocket market.

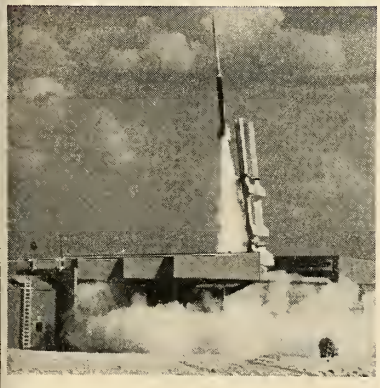
Canadian Bristol Aerojet Ltd., a joint offspring of Bristol Aeroplane Co., of Canada, Ltd. and Aerojet-General Corp., El Monte, Calif., is in the home stretch in the development of a full family of its *Black Brant* sounding rockets.

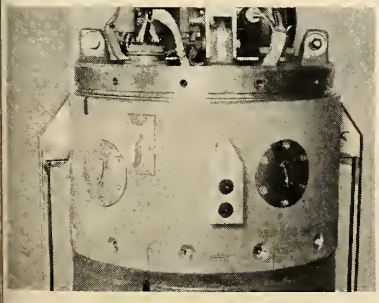
The *Black Brant IV*, a two-stage vehicle capable of lofting 40 lbs. to 600 miles altitude, ran into stage-separation problems in its first two development flights. However, CBA experts feel the trouble can be solved without a major schedule delay.

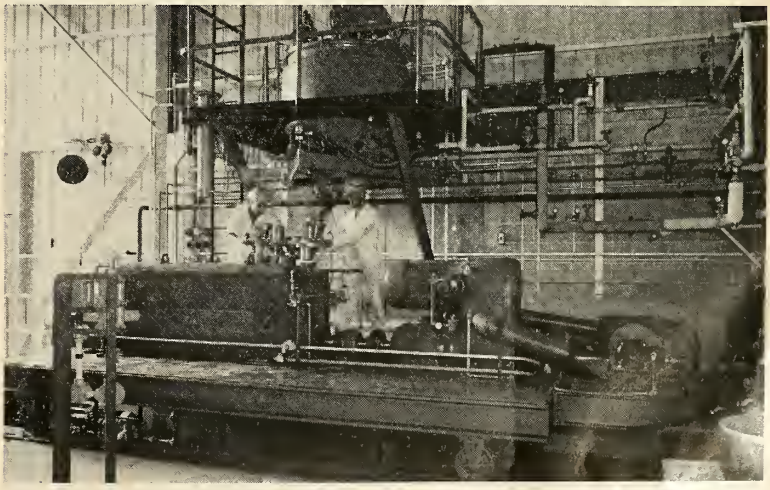
● **Flight test problems**—In firings at the Churchill Research Rocket Range in Northern Manitoba last June 24 and July 2, 1964, launch and boost phases went as planned but a lack of clean separation was apparent during both flights. The first shot had a spin factor while the second involved essentially no spin at all—yet both displayed the same separation disturbance.

Excellent telemetry records were received and these, together with range flight information are now being analyzed. CBA hopes to conduct the second round of development flights late this fall.

The development rocket is part of the firm's *Black Brant* series. These include the *Black Brant II*, a 17-in. single-stage, fin-stabilized vehicle capable of arcing 150 lbs. at 125 mi.; *Black Brant III*, a 10-in. single-stage version now capable of reaching 110 mi. altitude with 40 lbs., the two-stage *Black Brant*







TOP LEFT: Black Brant IV leaving sheltered boom-launch complex at Churchill. Lack of clean separation marred this and the following development shot. LEFT: Black Brant III igniter housing separates pyrotechnics from payload in addition to carrying quadra-loop antenna, solar aspect sensors (slits) and forward launch lugs. ABOVE: Huge horizontal mixer at Canadian Bristol Aerojet's Rockwood facility in Manitoba Province is shown being prepared for a propellant batch. Rockwood is a production plant, drawing on Aerojet and Canadian government for technology.



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We guide: After a system concept is determined and an industry team is selected by the Air Force, Aerospace co-ordinates, interprets, and guides the efforts of the contractors. Technical meetings are held where ideas are exchanged and system trade-offs discussed. Aerospace sifts and evaluates contractor progress toward the new and improved ballistic missile systems required.

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The problem is to take as many as you can of the 39 cars of your train from X to Y. Each time you back out of a siding you lose one car. Can you lose fewer than 19? This answer is given in *Mazes and Labyrinths, a Book of Puzzles*, by Walter Shepherd; Dover Publications, Inc., New York 14, N.Y.

AEROSPACE CORPORATION

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government

IV; and *Black Brant V*, a 17-in. single-stage capable of taking 150 lbs. to 240 mi. The last rocket will have its first development firing late this year.

While the rockets themselves are being developed, CBA is acquiring a talent for optimizing payload designs. Customers—in most cases Canadian universities interested in upper-altitude research—design their own payloads, but CBA often has the problem of integrating the payload with the vehicle.

This effort has resulted in a strong electronics ability in designing telemetry, altitude sensors and transmitting equipment compatible with the environment and operating characteristics of each member of the *Black Brant* family. CBA also handles the complete range documentation and *Black Brants* are already accepted at several U.S. installations as well as at Churchill.

The firm is gaining acceptance across Canada and is now busy developing both U.S. and European sounding rocket markets.

An example of the engineering ability present at CBA is the development and operational use of a new altimeter.

● **Nature aided altimeter**—CBA specialists designed and built a simple unit for determining the altitude of any *Black Brant* shot. Called a cosmic ray altimeter, the instrument is basically a radiation detector with an associated electronic counter circuit.

The instrument uses the well-defined belt of high-density cosmic radiation in the atmosphere known as the Pfotzer maximum. Flight reference information is telemetered to the ground station.

Although the intensity of the Pfotzer Maximum varies with geographical location, it generally is found around an altitude of 13 mi.

The counting rate recorded by the altimeter exhibits two peaks—one as the rocket passes up through the layer and the second on descent. Using the time interval between these two peaks and assuming a ballistic flight, the maximum altitude is easily calculated.

It is not necessary to determine the time of impact of the rocket. If the vehicle is still under power as it passes up through the reference layer, corrections can usually be made to the assumed ballistic flight path.

The instrument normally uses a standard IRIG commutated telemetry channel; if more accuracy is desired, however, a continuous telemetry channel is employed.

● **Solid processing**—Canada's only industrial solid-rocket propellant plant is CBA's $2 million complex at Rockwood, several miles north of Winnipeg.

The Rockwood plant consists of 13 buildings, including a combined office and inert operations center. The general offices, quality control labs, motor lining, degreasing, raw material receiving, maintenance and repair, and inert stores are lumped together in one area.

The next complex handles the premixing of the volatile fuel ingredients under exact temperature and humidity controls. Product from this facility meets the prepared oxidizer batches in the mixing and casting building.

As it stands now, the plant can process both polyurethane and polyester compositions. The horizontal ribbon-blade mixer is primarily a development of the Canadian Armament Research and Development Establishment, Valcartier, Quebec, with associated Aerojet-General production experience applied to the final facility.

Propellant and motor-case handling procedures are as modern as possible. This is best illustrated by the *Black Brant V* propellant.

This composition has a pot life of 65 minutes and the mixing cycle is about 30 minutes. The ribbon-blade set-up cleans itself automatically after use, entirely eliminating a process delay. Batches up to 3,000 lbs. can be mixed and cast. The oxidizer preparation capacity is 2,000 lbs./hour in a remotely controlled series of operations.

The rest of the production facility includes oxidizer storage, curing ovens, motor storage and grain machining. Grain trimming, inspection, nozzle and motor assembly are carried out in the final assembly and shipping building.

Motors and JATO units destined for test firing at the Rockwood plant are instrumented and conditioned in facilities designed for this purpose and then transferred to the 50,000-lb.-thrust test-stand area.

The horizontal test stand is completely equipped with the necessary equipment for automatic recording of data from the firings. Safety procedures throughout the plant are similar to those of comparable U.S. installations.

The facility meets the quality program set up by the U.S. Naval Weapons Laboratory, Dahlgren, Va. Besides the various *Black Brant* formulations, the plant has turned out production JATO units. It will soon begin another run as a result of winning a recent competition with some U.S. firms.

Rockwood is laid out as a production plant. Little or no propellant research will be performed by Canadian Bristol Aerojet. The firm will rely on Aerojet-General and the Canadian Armament and Defense Establishment for propellant advances.

Both parent companies—Aerojet-General Corp. and The Bristol Aeroplane Co. of Canada, Ltd.—supply CBA with technology. ■



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AEROSPACE CORPORATION

Goddard Seeks Scaling Laws To Cut Cost of Environmental Testing

by William Beller

FACED WITH the prospect of spacecraft "bursting the seams" of even the largest of today's environmental test facilities, engineers at NASA's Goddard Space Flight Center are starting an intensive search for modeling laws and superposition criteria.

Spurring their efforts is the difficulty of getting test time in Goddard's newest environmental chamber, the Space Environmental Simulator. Put into full operation this month, and designed to test full-scale spacecraft, this chamber can handle a maximum of five tests a year.

Because of its size, the chamber is used almost entirely for final checkout of spacecraft and equipment. When hardware reaches this stage, there is no time to do any but the most urgent developmental work. If a component fails here, the first thought usually is to eliminate it or replace it with one of known reliability.

Thus, the costliness, size and sophistication of large test facilities, such as the Goddard chamber, all militate against their use for anything but the most conventional environmental testing. Nobody is criticizing such testing, especially since it ensures the integrity of flight hardware, but there is concern over the problem of getting enough chamber time to develop new space hardware, particularly when tesing and not theory is required to produce many of the design answers. Furthermore, a point is foreseen where chamber size can no longer keep pace with spacecraft size. Even today, the booms on some spacecraft, such as the *Orbiting Geophysical Observatory*, will nearly scrape the walls of today's largest chambers.

● **Finding the scaling laws**—The environmental conditions experienced by space systems may run a broad spectrum: pre-launch conditions, power launch, orbital and space flight, planetary landing and dwell, and re-entry conditions. How a spacecraft reacts under these environments may possibly be determined by putting scaled-down models in a simulated environment—or by using full-scale segments of a spacecraft and then applying appropriate laws to relate the findings to the entire spacecraft.

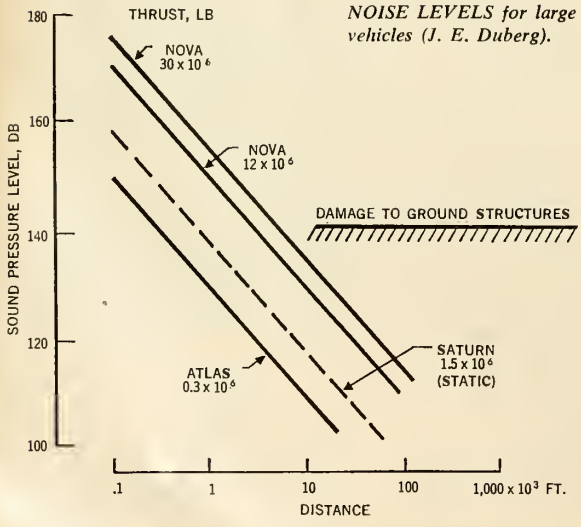
Aerodynamicists have been using these methods for years. Even before airplanes outgrew their tunnels, engineers were testing scaled-down models and then scaling the data up as a function of Reynolds number. Full-scale models of airfoils were used by the Wright brothers to gather wind-tunnel data for the design of their first airplane.

But the scaling and superposition laws for spacecraft are not so easily applied. Asked about this, D. C. Kennard, Jr., Technical Assistant for Advanced Research and Technology in Goddard's Test and Evaluation Division, pointed out to MISSILES AND ROCKETS the following goals in laboratory testing for future space systems:

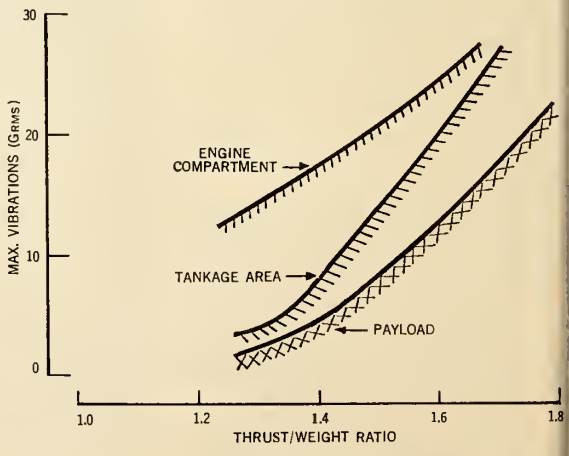
—Techniques to lessen the need for testing complete full-scale space systems in environmental simulators.

—Methods to refine environmental scaling laws and acquire complete understanding of environmental effects so that the system "build-up" technique and scale modeling can be used to complement each other in early phases of evolving space system designs.

—Ways to categorize test parameters and procedures in line with needs. In other words, separate materials evaluation from parts testing; parts testing from subassembly testing; subassembly from system testing, and so on.



NOISE LEVELS for large vehicles (J. E. Duberg).



BANDS OF MAXIMUM root-mean-square vibrations at strategic locations of launch vehicles during lift-off (G. W. Brooks).

• **Duplicating the Sun**—Even in the environmental-simulation technology itself, problems must be solved before modeling or superposition formulas can be applied. Kennard named three of the more pressing ones:

First, solar simulation techniques must be improved to produce closer correlation of thermal effects between ground-test and space operation. Improved spectral match and correlation factors between lamps and solar radiation, improved measurement techniques and more accurate control of sources would contribute to solving the problem.

Next, thermal and dynamic conductance of structural joints must be better understood, so that environmental factors brought in by launch and orbiting flight can be controlled during design of the space systems.

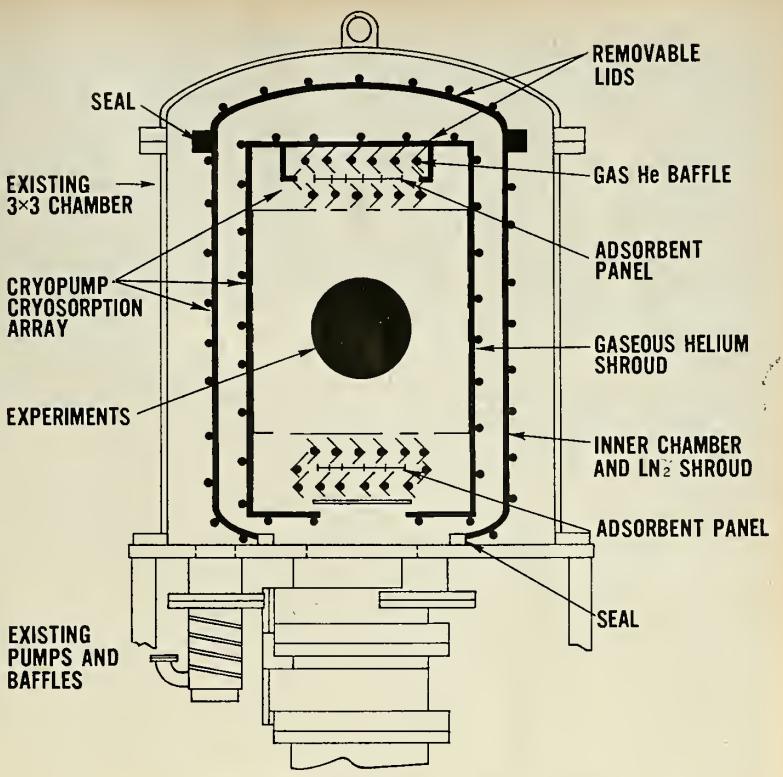
Last, adequate analytical and experimental methods must be developed for handling non-linear complex structural systems excited by non-stationary forces. With respect to large rockets, an understanding must be obtained of the problems of the impingement of intense low-frequency sound energy on the thin shells of future space systems and on large sprawling structures.

Goddard already has a leg up in some of this work. Through efforts of the late 1940's and early 1950's in flutter analysis for aircraft, structural dynamic modeling is already well advanced. In addition, some of the more difficult problems of thermal dynamic modeling such as joint conductance, "appear to be on the threshold of solution," Kennard says. Even magnetic modeling is being carefully considered.

"The main goal is to define the practical limitations of all these environmental modeling techniques," says Kennard, "and to use them within their useful context in complementing and validating other engineering approaches."

In this regard, Kennard outlined to M/R some of the work his group is doing on an in-house basis as well as through small contracts with industry. In the area of spacecraft magnetic environments, for instance, Goddard doesn't intend to go into scale modeling because the quantities of the magnetism involved are so small. But the group is trying to "build up" a magnetic profile of the *Orbiting Geophysical Observatory* based on the packages going into the spacecraft. The deduced profile will then be compared with the actual one in an effort to derive general correlation equations.

There are practical reasons for this. For example, one of the big problems in oriented scientific spacecraft, in addition to the possibility of magnetic interference among the payloads, is predicting and counteracting magnetic torque. This is the compass needle effect—that is, the interaction of the geomagnetic field with the magnetic field of the spacecraft. The thrustors will have to counteract this torque.



CONCEPTUAL DESIGN for cryosorption chamber.

• **Downscaling scales**—As a result of this problem, Goddard is looking into the feasibility of devising a system able to measure these spacecraft torques. Even here, the engineers are taking a leaf out of their modeling book; they will build scaled-down versions of probable devices to see if they work.

The problem is to develop a frictionless system sensitive to small torsional deflections. The torque range to be covered is from 10 to about 5,000 dyne-cm. One proposed system is to float the spacecraft in a fluid in order to eliminate friction. A torque is then impressed on the spacecraft and is resisted by a taut wire which puts in the restoring moment. The moment, of course, would be equal to the impressed torque.

For the practical case, the magnetic torque on the *Orbiting Astronomical Observatory* at 500 n. mi. is expected to be about 3,000 dyne-cm. Other environmental effects can also cause torques that will have to be resisted by a spacecraft thrustor system: gravity-gradient torque, about 1,500 dyne-cm in Earth orbit; solar-radiation torque, about 200 dyne-cm; and aerodynamic torque, about 300 dyne-cm.

One of the major problems bound up with modeling and building-up spacecraft out of their elements for test purposes is to evolve criteria which will govern the vacuum levels actually needed for adequate testing. Some components, for instance, are vulnerable to hard vacuum while others may not be.

• **Static pump**—To help solve this problem, Goddard is developing a relatively small vacuum facility able to pull 10^{-14} torr. To reach this vacuum, the engineers are using a relatively new idea: employing the cryosorptive material zeolite, which has a strong adsorptive affinity for gases. This material acts as a vacuum pump to reduce the pressure in a chamber after it has reached a certain low level.

In a comparison between pumping methods, cryosorptive pumping at 20°K is said to have pumping capacity for residual gases 20 times that of cryogenic-surface pumping at 4°K. This shows that with zeolite it is not necessary to go down to 4°K to get good pumping capacity.

Made by Linde Div., Union Carbide Corp., a test cryosorption panel will be delivered to Goddard next month. The shroud for the panel is expected within three months. The full facility will go into operation late this year. ■

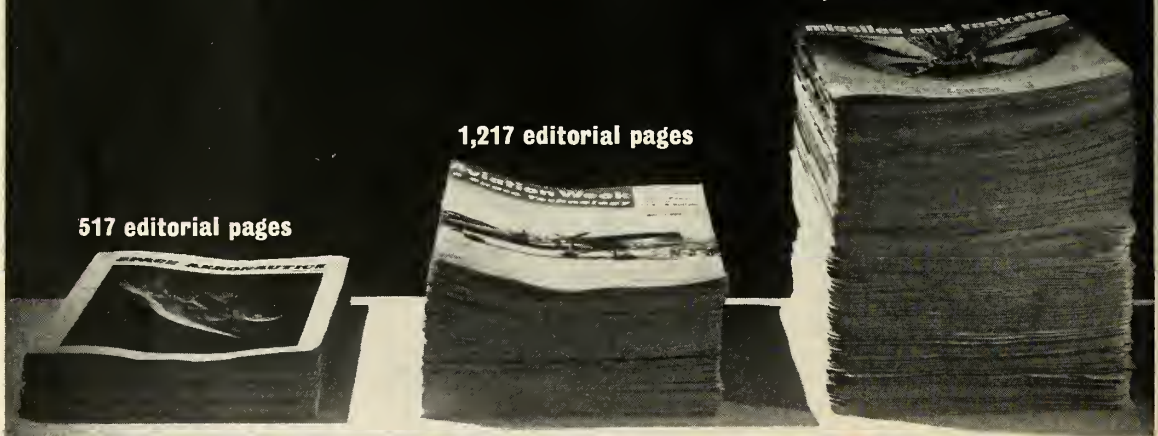
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The Industry Week

Mergers and Acquisitions

Pennsalt Chemicals Corp., Philadelphia, has acquired a majority interest in CryoVac, Inc., Columbus, Ohio, manufacturer of vacuum and low temperature systems. Management positions at CryoVac will not change. . . . *Beckman & Whitley, Inc., San Carlos, Calif., has purchased the the line of image converter cameras and accessory equipment of Abtronics, Livermore, Calif. Abtronics will continue production of image and photo tubes and the development of a new electronographic process.* . . . Protran Co., Inc., Hicksville, N.Y., is acquiring the transformer division of Ferranti Electric, Light Equipment Div., Plainview, N.Y. Plans are for expansion of the firm's overall capabilities in the transformer field. . . . *Stockholders of The Teleregister Corp., Stamford, Conn., have formally approved merger with Bunker-Ramo Corp., Canoga Park, Calif.*

New Activities

The Ohio Rubber Co., Cleveland, has formed an Aerospace Div. Eldon J. Steen was named manager. The company produces ablative materials for the *Titan III* rocket motor program and is conducting R&D work into thermal shielding materials. . . . *Amphenol-Microelectronics has been established in Broadview, Ill., as a division of Amphenol-Borg Electronics Corp., Chicago. The new organization is an outgrowth of Amphenol-Systems Packaging and will concentrate on microminiature electronic interconnections, custom packaging and thin-film deposition.* . . . Carmet Co. has been formed as a principal subsidiary of Allegheny Ludlum Steel Corp., Pittsburgh, Pa. The new company will consolidate the corporation's tungsten carbide facilities. Headquarters are in Pittsburgh. . . . *ITT board of directors has approved the formation of ITT Wire and Cable Div. by consolidation of ITT Surprenant, Inc., Clinton, Mass., and Royal Electric Corp., Pawtucket, R.I. The proposal becomes effective Aug. 1.* . . . Industrial Electronic Rubber Co. has formed a Precious Metals Electro Plating Div. Julian Sparkes will have charge of the operation. . . . *Amphenol-Borg Electronics Corp. has launched a quality control and reliability program, aimed initially at missile/space-type connectors. The firm has begun by identification of production units by specific coding numbers corresponding to information on production methods, materials, parts and life data.*

International

International Electronic Research Corp., Burbank, Calif., has licensed Winston Electronics, Ltd., Middlesex, England, to sell and manufacture the firm's line of electron tube shields and heat dissipators in the United Kingdom and the Commonwealth. . . . *Thomas & Betts Co., Elizabeth, N.J., manufacturer of electrical fittings, terminals and connectors, has purchased a 25,000-sq.-ft. plant near Montreal, Canada. The plant will provide production expansion for Thomas & Betts, Ltd., Montreal, a wholly owned subsidiary.* . . . JFD Electronics Corp., Brooklyn, N.Y., and Murata Manufacturing Co., Kyoto, Japan, have signed an agreement licensing Murata to act as exclusive distributor for JFD electronic components in Japan and other non-Communist Asian nations.

Company Facilities

Bell Aerosystems Co. has completed construction of a $750,000 altitude simulation facility at the Bell Test Center, Niagara County, N.Y. The facility will be used in development testing of the ascent rocket engine of the *Apollo* Lunar Excursion Module. The unit consists of a test chamber, a 20,000-gal. water tank, liquid oxygen and alcohol tanks and a 150-ft. ejector mounted on tracks. . . . *Unitrode, Inc., manufacturer of solid-state diode devices, has completed the first phase of a $3,000,000 expansion program in Watertown, Mass., with completion of a 30,000-sq.-ft. building.* . . . Bunker-Ramo Corp., Cleveland, Ohio, is opening a Numerical Control sales office in Dallas, Tex. Richard A. Roderick will head the new office. . . . *Spectral Dynamics Corp., San Diego, Calif., has moved to new facilities at 8159 Engineer Road.* . . . Sunbeam Electronics, Inc., will construct a 155,000-sq.-ft. plant near the Fort Lauderdale (Fla.) Executive Airport. The firm will be joined by Avionics Div. of John Oster Manufacturing Co. when the plant is completed in 1965. Sunbeam develops and produces missile/space instrumentation and systems. . . . *Stainless Steel Products, Inc., has completed a 45,000-sq.-ft. addition to its aerospace plant in Burbank, Calif. The expansion will provide facilities for assembling and X-ray testing of ducting and other parts for the Saturn V and other space vehicles.* . . . Telemetrics, Inc., has moved its office to Orlando, Fla. The supplier of PCM telemetry equipment was formerly located in Gardena, Calif. . . . *INTALCO Aluminum Corp. plans to construct an alumium reduction plant near Bellingham, Wash. Initial capacity will be 73,000 tons. Estimated cost of the plant is $60 million.* . . . National Seal Div. of Federal-Mogul-Bower Bearings, Inc., will move its administrative headquarters from Redwood City, Calif., to a location near Detroit, Mich., sometime next year. The firm also plans to begin construction soon on a research center in Ann Arbor, Mich. . . . *Armco Steel Corp., Middletown, Ohio, has announced plans of a multi-million-dollar plant improvement program for its Butler Works, Butler, Pa. The $600-million program includes nearly doubling present steelmaking capacity and installation of degassing and continuous casting facilities.*

LTV Swaps for 850,000 Common Shares

Ling-Temco-Vought, Inc., received more than 850,000 shares of its common stock in return for a new Series B preferred stock. The Dallas firm's tender-exchange offer expired July 2 (M/R, June 8, p. 43; June 29, p. 37).

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contracts and procurements

AWARDS

AIR FORCE

$34,875,750—**The Boeing Co.,** Seattle, Wash., for the first phase of site activation at Grand Forks, N.D., intercontinental ballistic missile wing.

$12,600,000—**General Electric Co.,** New York City, for operation and maintenance of radar equipment in Alaska and overseas. Contract also includes manufacture of gas turbine engine.

$11,300,000—**ITT Federal Laboratories,** Nutley, N.J., to provide radar and electronic equipment.

$5,000,000—**Tasker Instruments Corp.,** Van Nuys, Calif., for a tracking radar system.

$4,200,000—**Aerojet-General Corp.,** Sacramento, Calif., for *Minuteman* engine production.

$4,000,000—**ITT Federal Laboratories,** Nutley, N.J., for engineering services related to advanced communications systems.

$3,300,000—**Radio Corp. of America,** Moorestown, N.J., for operation and maintenance of a radar test facility.

$3,100,000—**Marquardt Corp.,** Van Nuys, Calif., for work on a classified project and for further work on an hypersonic ram-jet engine.

$2,600,000—**Ling-Tempco-Vought, Inc.,** Dallas, for continued R&D work on Gemini-X for *MOL.*

$1,800,000—**IBM Corp.,** New York City, for engineering services, supplies and EDP equipment rental.

$1,800,000—**Cornell Aeronautical Laboratory, Inc.,** Buffalo, N.Y., for work on a classified project.

$1,800,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued R&D on the *Titan III* Transtage rocket engine.

$1,500,000—**Canadian Iron Co.,** Vancouver, B.C., Canada, for construction of DEW Line billboard antennas across northern Canada.

$796,000—**General Dynamics Corp., Electronics Div.,** Rochester, N.Y., for range instrumentation control system.

$600,000—**General Dynamics Corp., Astronautics Div.,** San Diego, Calif., to build a checkout set for Azusa and Glotrac transponders.

$500,000—**General Dynamics, Astronautics Div.,** San Diego, Calif., for production of nine improved transponders for *Glotrac.*

$138,031—**The Gerstenslager Corp.,** Wooster, Ohio, for a transportable telemetry station enclosure.

$62,500—**Trustees of Princeton University,** Princeton, N.J., for solid propellant combustion instability study.

Northrop Corp., Nortronics Div., Anaheim, Calif., to continue developing advanced air-to-ground weapons concepts (amount undisclosed).

Garrett Corp., AiResearch Manufacturing Div., Los Angeles, a contract to develop a miniaturized helium level refrigeration system for space vehicle applications (amount undisclosed).

ARMY

$14,100,000—**ITT Federal Laboratories,** Nutley, N.J., to furnish equipment and install communications systems.

$1,800,000—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for design changes with respect to *Shillelagh* missile capabilities.

$1,750,000—**Ryan Aeronautical Co.,** Los Angeles, for missile targets and ground launch facilities.

$480,000—**Fairchild Camera and Instrument Corp., Fairchild Space and Defense Systems Div.,** Syosset, N.Y., for advanced development models of the KA-60 70-mm panoramic surveillance system.

$303,035—**Sperry Rand Corp., Sperry Utah Co.,** Salt Lake City, Utah, four contracts for repair parts for *Sergeant* missile systems.

$71,526—**Intercontinental Mfg. Co., Inc.,** Garland, Tex., for *Sergeant* rocket motor case assembly.

$50,000—**Bissett-Berman Corp.,** Santa Monica, Calif., to fabricate and test under rigorous environmental conditions a new type of timing device that is about one-half cubic in. in size, has no moving parts, can be set for intervals from 8-48 hours, and will work reliably after a one-year storage period.

$28,386—**Ultrasonic Industries, Inc.,** Plainview, N.Y., for 171 tank immersion solvent degreasers.

$23,316—**Intercontinental Mfg. Co., Inc.,** Garland, Tex., for *Sergeant* nozzle assembly, rocket motor.

NAVY

$23,932,938—**ITT Corp.,** and subsidiary, New York City and Paramus, N.J., for production of detecting devices for Navy's *Tartar* missile and for provision of logistic support for DEW system.

$20,000,000—**Hughes Aircraft Co.,** Culver City, Calif., for continued production of the *Phoenix* air-to-air missile system.

$19,900,000—**Thiokol Chemical Corp.,** Bristol, Pa., for continued production of *Bullpup* missile pre-packaged engines.

$12,100,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., two contracts for rocket motors for *Shrike* missiles and *Sparrow III* missiles, and for target rocket drone engines.

$7,145,700—**Bendix Corp.,** Detroit, to provide continued maintenance and operation services at various sites on the Pacific Missile Range.

$5,600,000—**Dynalectron Corp.,** Washington, D.C., for three contracts to provide data processing at Pacific Missile Range, and for production of relays and switches for use in engine analyzers.

$5,000,000—**Perkin-Elmer Corp.,** Norwalk, Conn., to produce highly advanced aerial reconnaissance systems for use in the RA-5C *Vigilante.*

$2,800,000—**FMC Corp.,** Minneapolis, Minn., for rocket launcher training equipment.

$2,700,000—**Raytheon Co.,** Lexington, Mass., for *Sparrow III* missile engineering services.

$1,842,872—**Astrodata, Inc.,** Anaheim, Calif., for a telemetry data system for the Pacific Missile Range.

$1,000,000—**Defense Electronics, Inc.,** Rockville, Md., for telemetry-communications equipment and systems.

$1,000,000—**Loral Electronics Corp.,** New York City, for target-bearing and range display systems, applicable to *Polaris* FBM subs.

$792,616—**Norris-Thermador Corp.,** Los Angeles, for a rocket motor.

$665,974—**American Cyanamid Co.,** Stamford, Conn., for R&D on high energy oxidizers.

$508,914—**Vitro Corp. of America, Vitro Laboratories Div.,** Washington, D.C., for two fixed-price ordnance contracts.

$398,922—**Minnesota Mining and Manufacturing Co.,** St. Paul, Minn., for R&D on high energy oxidizers.

$360,000—**Planning Research Corp.,** Los Angeles, Calif., for follow-on contract to continue analysis and specification of information flow requirements for a Navy-supported command.

$349,605—**Sanders Associates, Inc.,** Nashua, N.H., for RDT&E of ocean surveillance capability using satellites.

$260,000—**ARINC Research Corp.,** Washington, D.C., for four system effectiveness study contracts.

$220,000—**Aerojet-General Corp.,** Azusa, Calif., for missile propellant R&D work.

NASA

$22,378,626—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for four F-1 engine modifications.

$6,839,069—**Rust Engineering Co., Mason-Rust Div.,** Pittsburgb, for a six-montb contract extension option for continued provision of support services at the Michoud Operations, manufacturing site for *Saturn* rocket first stages.

$3,600,000—**ITT Corp., Federal Electric Corp.,** Paramus, N.J., for a three-year contract to provide instrumentation support services of the Merritt Island Launcb Area.

$2,145,710—**Electronic Communications, Inc., St.** Petersburg, Fla., for the production of flight control computers for the *Saturn-V* and *Saturn IB* programs.

$1,200,000—**Ling-Temco-Vought, Inc.,** Dallas, for a space research component.

$1,125,000—**University of Illinois,** Urbana, to finance construction of research laboratory facilities.

$915,000—**Bissett-Berman Corp.,** Santa Monica, Calif., for studies pertaining to *Apollo* mission planning and analysis of guidance and navigation systems.

$450,788—**Wyle Lahoratories Inc.,** Huntsville, Ala., for environmental testing of the *Saturn IB* and *V* instrument units.

$402,080—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for chamber technology for storable propellants in space.

$344,394—**Cornell Aeronautical Lahoratories,** Buffalo, N.Y., for *Apollo* re-entry studies.

$316,958—**Space General Corp.,** El Monte, Calif., for *Aerobee 150* sounding rockets.

$308,000—**Honeywell, Inc., St.** Petersburg, Fla., for an airborne digital computer.

$259,105—**Hughes Aircraft Co.,** Malibu, Calif., for development of linear strip ion thrustors for attitude control.

$254,590—**Interstate Electronics Corp.,** Anaheim, Calif., for generalized tracking receivers.

$218,450—**Geophysics Corp. of America,** Bedford, Mass., for a sodium vapor experiment.

$200,719—**Thiokol Chemical Corp.,** Elkton, Md., for *Cajun* and *Apache* rocket motors.

$191,800—**Aracon Geophysics Co.,** Concord, Mass., for *APT(Tiros)* on-board gridding system.

$180,000—**Giannini Scientific Corp.,** Santa Ana, Calif., for design and development of thermoionic electric thruster.

$146,969—**University of Minnesota,** Minneapolis, for an OSO-E experiment.

$117,945—**Canadian Commercial,** Ottawa, Canada, for a meteoroid impact bumper program study.

$103,299—**General Dynamics Corp., General Atomics Div., San** Diego, Calif., for a study of the radiation effects on silicon solar cells.

INDUSTRY

$20,000,000—**Thompson Ramo Wooldridge, Inc., Space Technology Lahoratories, Los Angeles,** from **Grumman Aircraft Engineering Corp.,** Bethpage, N.Y., for work on Lunar Excursion Modules.

$5,000,000—**Perkin-Elmer Corp.,** New York City, from **North American Aviation, Inc.,** El Segundo, Calif., aerial reconnaissance systems for Navy's *Vigilante* aircraft.

$3,000,000—**General Dynamics, Convair Div., San** Diego, from **Pan American Airways, Inc., Guided Missiles Range Div.,** Patrick AFB, Fla., for follow-on program to integrate advanced telemetry instrumentation equipment required to support and monitor launch operations at AF Eastern Test Range.

$2,750,000—**American Machine & Foundry Co., Advanced Products Group,** New York City, from **GT&T, Sylvania Electric Products, Inc.,** New York City, for installation and test of bardened underground cable communication system for *Minuteman* Wing VI at Grand Forks, N.D.

$1,000,000—**Marquardt Corp.,** Los Angeles, from **North American Aviation, Inc., El Segundo, Calif.,** to design and develop an advanced ramjet engine for the Army's *Redhead-Roadrunner* target missile.

ARMS CONTROL AND DISARMAMENT AGENCY

$48,955—**Los Angeles State College Foundation,** Los Angeles, for a study of various significant aspects of certain arms control and disarmament agreements concluded during the period 1919-1939 that could be useful to tbe United States in the conduct of future international negotiations.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Purchasing Office
Marsball Space Flight Center
Huntsville, Alabama
Attn.: PR-RG

Develop and fabricate a series of high-density flat conductor cables of insulated flat copper conductors. RFP due 8/13/64. Ten firms are being solicited initially.

National Aeronautics and Space Administration
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Design, develop and calibrate an instrument to measure velocity of gas phase wben liquid and gas is flowing in a duct. RFP ADE 3129 due 7/24/64.

Office of Naval Research
Washington 25, D.C.

Negotiations are to be conducted with Keithley Instruments, Inc., Cleveland, Ohio, for further research on prototype models of electrometer circuitry for satellites and rockets under Contract Nonr-2843 (00)(X). RFP not available; for information only.

National Aeronautics and Space Administration
Lewis Researcb Center
21000 Brookpark Road
Cleveland, Ohio 44135

Proposals to be solicited for an analytical study of the feasibility of an all-pneumatic neutron flux sensor. RFP ADE 3128 to be released approximately 7/17/64. Bid opening approximately 8/17/64.

National Aeronautics and Space Administration
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Negotiations will be conducted with Clevite Corp., Electronic Researcb Div., 540 East 105th St., Cleveland, for a program to advance the development of cadmium sulfide thin-film pbotovoltaic cells. RFP not available; for information only.

National Aeronautics and Space Administration
Marshall Space Flight Center
Contracts Office
Huntsville, Alabama

RFP for modification of 16 RL-10 engines to the RL10A-3-CM1 configuration issued. Only Pratt & Whitney Aircraft, P.O. Box 2691, West Palm Beach, Fla., will be invited to participate. Firms interested in this procurement should directly contact the above firm.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

Negotiations will be conducted with Electronic Associates, Inc., Palo Alto, Calif., for rental of various analog computer equipment during Fiscal 1964. For information only. RFP not available.

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Redstone Arsenal, Alabama 35809

Contract DA-01-021-AMK-11221(Z) awarded to Raytheon Co., Lexington, Mass., for procurement of missile system (*Hawk*) test equipment. Firms interested in subcontracting opportunities should contact the above firm.

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Redstone Arsenal, Alabama 35809

Contract DA-01-021-AMC-11227(Z) awarded to Emerson Electric Co., 8100 Florissant Ave., St. Louis, Mo., for the procurement of pedestals and forward motor fairings for *Honest John* system. Firms interested in subcontracting opportunities should contact the above firm.

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Redstone Arsenal, Alabama

Contract DA-021-AMC-10840(Z) awarded to Sperry Rand Corp., Sperry Utah Div., 322 North 21st St., Salt Lake City, Utah, for procurement of *Sergeant* missile system training equipment. Firms interested in subcontracting opportunities should contact the above firm.

National Aeronautics and Space Administration
Manned Space Flight Branch, Headquarters
Contracts Division
Washington, D.C. 20546

Negotiations with Excelco Developments, Inc., Silver Creek, N.Y., are in progress for continued study of optimum fabrication metbods of solid rocket cases in the six to eight-million-pound thrust stage. RFP not available; for information only.

National Aeronautics and Space Administration
Flight Research Center
P.O. Box 273
Edwards, California 93523

Negotiations will be conducted with AiResearch Manufacturing Div., Garrett Corp., Los Angeles, Calif., for development, design, fabrication and flight testing. For information only; RFP not available.

U.S. Army Missile Command
Procurement and Production Directorate
Procurement Operations Office
Redstone Arsenal, Alabama 35809

Contract DA-01-021-AMC-11185(Z) awarded AMCEL Propulsion Co., division of Celanese Corp. of America, P.O. Box 3049, Asheville, N.C., for study of meteorological rocket falling mass hazard. Firms interested in subcontracting opportunities should contact the above firm.

National Aeronautics and Space Administration
Manned Spacecraft Center
Gemini Test & Operational Support Procurement
Houston, Texas 77058

Lease of solid-state digital computer. IFB MSC BG 21-10-5-1-B opening 7/28/64. Copes will be furnisbed as long as supply lasts. Contact J.E. Jones Jr.

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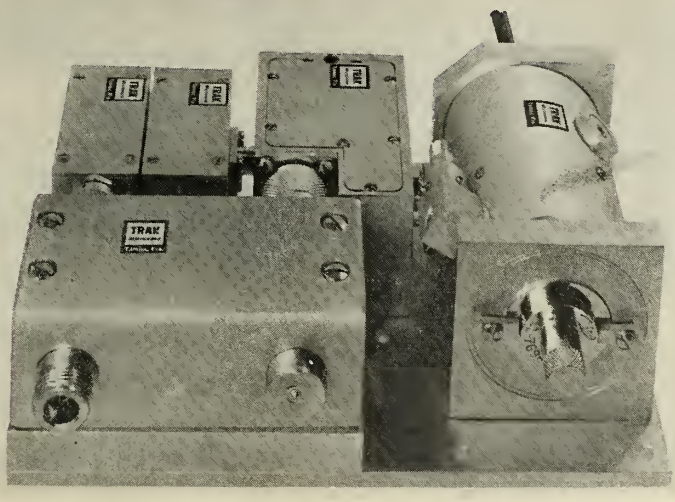
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New Product of the Week: RF Assembly

Trak Microwave Corp. has available an RF assembly consisting of a transmitter oscillator, local oscillator, circulator and limiter/mixer.

The Model 2971-1013 has an operating frequency of 1,610 mc. Peak power output is 5 kw minimum at antenna port of load VSWR of 1.2 maximum. Pulse width is 1.0 microsec. Load VSWR is 3.1 maximum at all phase angles. Operating temperature range is −20° to 100°C.

Circle No. 151 on Subscriber Service Card

Thermocouple

The Model 257 thermocouple, designed to measure temperatures up to 6,000°F, is being marketed by Marshall Precision Products.

The non-metallic device can be used to extended periods at temperatures up to 4,200°F and for shorter periods to 6,100°F. Millivolt output is said to exceed that from exotic metal thermocouples by approximately 2:1. Response times as low as 250 msec. are available. The unit is available in a variety of configurations.

Circle No. 152 on Subscriber Service Card

Differential Preamplifier

Honeywell, Inc.'s Denver Div. is marketing an 8-channel differential preamplifier designed to couple a differential source with instruments requiring a single-ended input.

The device provides gains of ½, 2, 10 and 40. Each channel has a 6-position switch providing the four gain positions plus input and output short and two screwdriver potentiometers, one adjusting to greater than 60-db rejection of common mode voltages and the other setting the dc level of the output to 0 volts for 0 input.

Circle No. 153 on Subscriber Service Card

Silicon Logic Module

A line of 1-megacycle silicon logic modules has been announced by Applied Development Corp.

The series has a "true" logic level of 8.2v ±0.5v and a "false" logic level of 0v ±0.5v. Standard ac load is 7.6 ma; standard dc load is 2.3 ma. Rise time is 0.1 μsec and noise rejection is rated at 3v. The series operates in an ambient temperature range of 0 to 85°C and can withstand relative humidity of 95% and vibration of 2 g's from 0 to 500 cps.

Circle No. 154 on Subscriber Service Card

Resolver/Amplifier

Kearfott Div. of General Precision Aerospace has developed a size 15 resolver/amplifier combination for data transmission and great circle computer chain applications.

The CTO 9624 005 offers the resolver and dual channel amplifier as separate components for side-by-side mounting and holds transformation ratio and phase shift constant. Input impedance is 100 k ohms and function error is ±0.1%. Operating temperature range is −40° to 71°C.

Circle No. 155 on Subscriber Service Card

Mixing/Metering Machine

A mixing and metering machine for dispensing multi-compound adhesives and sealants either continuously or intermittently is being marketed by ITT Bell & Gossett, Inc.

The Meter Mix is a portable unit featuring a vacuum de-aeration system that uses between 25 and 27 in. of vacuum to remove entrapped air and gas in the base material.

Circle No. 156 on Subscriber Service Card

Digital Voltmeter

A line of digital voltmeters designed to operate at speeds of one conversion per millisecond has been introduced by Electronic Associates, Inc.

The Series 6000 and 6001 are completely programmable through circuit closures to ground and provide both binary coded decimal and 10-line decimal outputs. The units have four ranges up to 1,200v and resolution of 100 mv. They are calibrated to ±0.1% of reading plus 1-digit absolute accuracy. Input is 115/230v ±10%, 50 to 60 cps.

Circle No. 157 on Subscriber Service Card

Differential Microvoltmeter

Medistor Instrument Co. is marketing a differential microvoltmeter designed to measure voltages from 1μv to 1,000v in five ranges.

Features of the solid-state Model



A-75 include an accuracy of ±0.02% +½ μv; null detector resolution of ¼ μv; recovery time from overloads typically less than 10 sec. to within 1μv; input impedance infinite below 10v and 5 megohms on the higher ranges. Terminal linearity of the divider is better than ±0.002%.

Circle No. 158 on Subscriber Service Card

Bridging Transformer

A precision toroidal transformer for bridging, oscilloscope isolation and video coupling applications is available from Arnold Magnetics Corp.

The unit is close-coupled to provide operation from 100 cps to 1 mc. Internal shields minimize capacitance to the ground plane. Four windings provide various ratio combinations to impedance levels of 100 k ohms. The unit measures 1.44 in. diameter and 0.76 in. high and meets MIL-T-27A and MIL-E-5272D specifications.

Circle No. 159 on Subscriber Service Card

CRT Recorder

The Model OR-285 cathode ray tube recorder, which combines magnified images from a CRT and up to eight conventional galvanometers onto a single moving 12-in. permanent film or paper record, is available from Interstate Electronics Corp.

The device records at spot image speeds up to 200,000 ips. Resolution is 500 line pairs on 10 in. of recording media. The tube is linear, flat to 20 kc in the swept axis, and is intensity modulated by a 4-mc video amplifier. Other features include visual monitoring of the tube face while recording and record identification.

Circle No. 160 on Subscriber Service Card

Backward Wave Oscillator

Sperry Electronic Tube Div. has developed a backward wave oscillator, reported to be the first of its kind focused with a PPM assembly.

The tube measures 4⅞ x ⅞ in. and weighs 7 oz. It delivers a guaranteed minimum of 10 mw across frequencies from 15.8 to 17.0 gc. Beam voltage range is 950 to 1,300v; beam current is 25 ma maximum.

Circle No. 161 on Subscriber Service Card

Volt/Ratio Divider

A standard volt/ratio divider featuring 1-ppm accuracy is available from General Resistance, Inc.

The Model DV-4107 is a seven-dial voltage divider with a resolution of 0.1 ppm. Failure rate is 0.01% per 1,000 hrs. at a 60% confidence level. Other features include rear access terminals, redundant switching and direct reading numeric display.

Circle No. 162 on Subscriber Service Card

Temperature Indicator

The Temperature Spread-Check Module, capable of providing average or individual temperature readings of thermocouples, is being marketed by Consolidated Airborne Systems, Inc.

The Model DSA-194 has a response time of 6 secs. from 0 to full scale. Accuracy is ±3°C or ±6°F at an ambient temperature of 25°C. Readability is 0.5°F. Input is 115v, 400 cps. Operating temperature range is −40° to 55°C.

Circle No. 163 on Subscriber Service Card

Vacuum Evaporator

Kinney Vacuum Div. of the New York Air Brake Co. is marketing the KSE-2 vacuum evaporator, capable of reaching 10^{-4} torr in four minutes. Pressures as low as 5 x 10^{-7} torr are available.

The unit consists of a 2-in. diffusion pump, a liquid nitrogen cold trap, combined with a water-cooled baffle and a 3-cfm mechanical vane-type pump.

Circle No. 164 on Subscriber Service Card

Power Module

A compact power module especially designed for 400-cycle power is being produced by Abbott Transistor Laboratories, Inc.

At 60 watts output, the unit can supply any required voltage from 5 to 3,650v dc. Forty-watt models can supply voltages to 10,400v. Adjustment range is 12% nominal. Regulation is 0.2% for line variations of 105 to 125v ac. The unit meets MIL-E-5272C environmental requirements; operating temperature range is −65° to 160°F.

Circle No. 165 on Subscriber Service Card

Audio Transformer

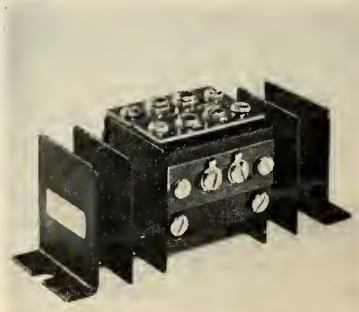
Raytheon Co.'s Magnetics Operation is marketing a line of subminiature audio transformers designed for printed circuit and transistorized circuit applications.

The Autospec Series 7600 offers frequencies from 100 cps to 500 kc and power handling capabilities from 50 mw to 1.0 watt. Audio inductors are rated from 0.2 millihenries to 40 henries. The unit measures 0.41 x 0.31 x 0.47 in. and meets MIL-T-27B requirements. Slip-on shields are available to provide magnetic shielding.

Circle No. 166 on Subscriber Service Card

Solid-State Relays

The SCR series of solid-state relays, said to be unaffected by shock, vibration, altitude or humidity, is available



from Philadelphia Scientific Glass Co., Inc.

The units provide current ranges from 5 to 25 amps and voltage ranges from 6 to 400v ac. Average control current is 10 ma; ambient temperature range is −40° to 212°F. Each unit operates in a normally open or normally closed pattern.

Circle No. 167 on Subscriber Service Card

Programming Cam Timer

A miniature programming cam timer offering 1 to 4 individual load switches is being marketed by Industrial Timer Corp.

The Series CLV timer is available with time cycles ranging from 6 secs. to 3 hrs. or more. Load switching is accomplished with internal switches carrying loads up to 15 amps, non-inductive.

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Magnetic Tape Degausser

A bulk degaussing system for magnetic tape that eliminates high-power input and manual handling requirements has been announced by Magnusonics Industries, Inc.

In the D1250 system, the reel is rotated in a traveling magnetic field which crosses the reel four times to provide complete erasure. Erasure can be effected on reels up to 14 in. in diameter with widths up to 2 in. Erasure time is approximately 130 secs.

The unit produces a field of 1,450 gauss and draws 5 to 7 amps when operated from a 117-v, 50 to 60-cps single-phase source.

Circle No. 169 on Subscriber Service Card

Gaussian Noise Generator

Elgenco, Inc., is marketing the Model 610A Gaussian noise generator featuring eight frequency ranges selectable by a front panel switch.

Lower end of each range is 10 cps; upper ends are 2, 5, 20, 50, 200 and 500 kc and 2 and 5 mc. The spectrum is uniform to ±0.5 db from 10 cps to 500 kc and ±2 db from 500 kc to 5 mc. One-volt RMS output is available on all ranges. Output impedance is 50 ohms.

Circle No. 170 on Subscriber Service Card

Instrument Motors

Electronic Specialty Co. has introduced a line of instrument motors. Available designs include normal and high-slip induction, reluctance synchronous, hysteresis synchronous and low-inertia servo. Operating temperature range is 0° to 40°C. Features include an encapsulated stator, elimination of end caps and location of bearings in the stator bore, die-cast rotor and Delrin first-stage gears. All parts are ultrasonically cleaned prior to assembly.

Circle No. 171 on Subscriber Service Card

Pulse Generator

An explosion-proof pulse generator designed for digital measuring and control systems in hazardous or severe applications is available from Avtron Manufacturing, Inc.

The Model T535 has a maximum output frequency of 40 kc and pulses per revolution of 1 through 360. Usable speed range is from 10 to 5,000 rpm or 10 to 10,000 rpm.

Circle No. 172 on Subscriber Service Card

Balanced Mixer

Sanders Associates, Inc., Microwave Products Dept. has available a subminiature balanced mixer weighing less than 0.5 oz. and measuring 1½ in. in diameter and ⅛ in. thick.

The series CM 504 is available in both S-band and C-band with a 20% bandwidth. Typical noise figure is 8 db; typical conversion loss is 7 db.

Circle No. 173 on Subscriber Service Card

Ultrasonic Transducer

An ultrasonic standard production transducer, known as the SOMAT, has been introduced by Delta Sonics, Inc.

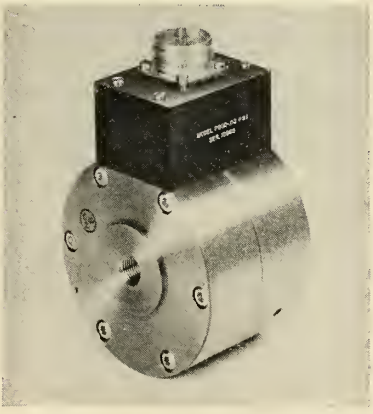
The device is designed for use in welding, soldering, grinding and brazing and can be operated intermittently or continuously. Constructed of stainless steel and aluminum, the device has a power handling capability of 200 watts continuous (unloaded) at 21 kc (resonant frequency).

Circle No. 174 on Subscriber Service Card

Differential Transducer

Pace Engineering Co. is marketing a low-range differential pressure transducer, designed to withstand overloads up to 100 psi without damage.

The Model P90D is operable at line pressures from vacuum to 1,000 psi. It accepts corrosive liquids and gases both sides and delivers full scale output of 50 mv/v in bridge circuits with an accuracy of ±0.5% full scale. The sens-



ing element is a thin magnetic stainless diaphragm, which deflects with pressure and controls the inductance ratio between two pick-off coils embedded in the case.

Linearity is within ±½% best straight line; hysteresis is within ±0.1% pressure excursion. Ambient temperature range is −65° to 250°F.

Circle No. 175 on Subscriber Service Card

Telemetry Transmitters

Microdot, Inc., is marketing a line of UHF telemetry transmitters designed for applications in the 1,400 to 1,600-mc range.

Features include a pulse-counting type discriminator, frequency stabilizing circuitry and Nuvistor tube design to eliminate the use of semiconductors. The device operates with a 100-watt CW power output and meets IRIG standards and AIA performance requirements. It is suitable for both narrow band FM/FM systems or wideband PCM systems.

Circle No. 176 on Subscriber Service Card

Noise Calibration Source

Solitron Devices, Inc., is marketing a 10 mc to 1 gc variable output noise source, calibrated at 100 to 900 mc relative to matched load and standard temperature of 293°K.

The Model SD3-NSV incorporates a current-controlled attentuator to control noise output level. Noise rating is from 2×10^4 °K to greater than 10^7 °K referenced to a 50-ohm resistor. Power requirements are 75 to 150v dc, 10 ma maximum.

Circle No. 177 on Subscriber Service Card

Log-Spiral Antennas

Stoddart Aircraft Radio Co., Inc., has available two conical log-spiral antennas designed for use with RFI measurements in the 200-mc to 10-gc frequency range.

The 50-ohm antennas are of a broadband type with no tuning adjustments required. They meet MIL-STD-826 specifications.

Circle No. 178 on Subscriber Service Card

Forward/Backward Counter

Janus Control Corp. has developed an all-silicon forward/backward decade counter for use in computing, control and data acquisition systems.

A major feature of the Model B100-80 is a capability to arbitrarily set the output voltage level, making possible use with a variety of standard and non-standard logic control levels. Counting rated is specified as 2 megacycles; maximum reversing delay time is 1 microsec. The device uses an 8-4-2-1 BCD counting technique.

Circle No. 179 on Subscriber Service Card

Contamination Monitor

A total flow contamination monitor, the Model 861-F Totamitor, has been developed by Bowser, Inc.'s Bowser-Briggs Filtration Div.

The device is designed to measure and record the level of contamination present in any transparent liquid. It uses a scattered light principle, detecting light reflected from solid or immiscible liquid particle of contaminant. The signal produced is amplified for operation of any alarm, signal light, direct-reading meter or recorder. Features include ac or dc electrical characteristics and flange or victaulic connections.

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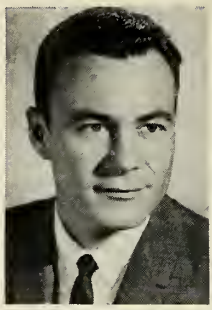
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names in the news


BLAIR


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THOMAS

Dudley D. Fuller: Appointed Chairman of the Department of Mechanical Engineering at Columbia University, New York City.

J. W. Crosby: Elected chairman of the board of Thiokol Chemical Corp., Bristol, Pa. **H. W. Ritchey** succeeds Crosby as president. **F. W. Wilson, C. E. Hunter, R. L. Marquardt** and **R. E. Davis** named vice presidents.

Sidney Zimmerman: Appointed corporate vice president-finance of Operations Research Inc., Silver Spring, Md.

John B. Bennett: Joined the staff of the American Society for Engineering Education as Editor of Publications. He will be located in Washington, D.C.

Edwin M. Vaughan: Assumed position of Physical Science Administrator at the U.S. Army Weapons Command, Rock Island, Ill. He was formerly chairman of the Physics department at St. Ambrose College, Davenport, Iowa.

George D. Valley, Jr.: Appointed chairman of the board of Electronic Space Structures Corp., West Concord, Mass. **Albert Cohen** was elected president and **S. C. (Terry) Nilo** was promoted to vice president of the corporation.

Ronald R. Blair: Promoted to vice president-engineering of Stainless Steel Products, Inc., Los Angeles.

James V. Bitner, Jr.: Named president of the Instrument Div. of Lear Siegler, Inc. He was formerly vice president of the division.

Marvin Stern: Joined Aerospace Group, General Precision, Inc., Little Falls, N.J., as a vice president. He was formerly deputy director of Defense Research and Engineering in the Department of Defense.

W. D. Rasdal: Appointed assistant to the vice president and general manager of Thompson Ramo Wooldridge subsidiary, TRW Semiconductors Inc.

N. H. (Mike) Axler: Inventor of the electric-eye camera and originator of the ultra-violet interference filter, has joined Sier-Bath Co., Inc., North Bergen, N.J., to head its Electro-Optical Instruments Div.

J. Earl Thomas, Jr.: Joined General Instrument Corp., New York City, as corporate new products manager and technical adviser to the president. He was formerly with IBM Components Div.

Ernest W. Lareau: Appointed director of the Philco Technological Center, Philadelphia. He was formerly manager of computer training and publications for Philco's Communications and Electronics Div.

Charles V. Wagner: Appointed vice-president-sales of Brown and Perkins, Inc., Perth Amboy, N.J.

Frank A. Glassow: New director of engineering of the Whittaker Corporation's Controls and Guidance Div. in Chatsworth, Calif.

George W. Deskin: Appointed to the newly created position of staff scientist for Applied Technology, Inc., Palo Alto, Calif. He was formerly a full-time consultant for DDR&E at the Department of Defense.

John R. Luneau: Elected president and general manager of Solid State Instruments Corp., a subsidiary of Kollmorgen Corp., Cambridge, Mass. He is also vice president of product research for Kollmorgen.

James Colker: Elected executive vice president of C. P. Goertz American Optical Co., Inwood, N.Y. **Kenneth Kemp** also elected vice president-engineering.

Kenneth E. Weaver: Joined Machlett Laboratories, Inc., Springdale, Conn., as member of the sales engineering staff of the central region. Machlett is a subsidiary of the Raytheon Co.

Arthur J. Muir: Named eastern regional sales manager for Miniature Precision Bearings, Inc., Keene, N.H.

Arthur G. Walsh: Elected a director and vice president in charge of the Chemical Machinery div., of Baker Perkins Inc., Saginaw, Mich.

—when and where

JULY

Gordon Research Conference on Critical Tables and Progress in Science, Air Force Office of Scientific Research, New Hampton, N.H., July 20-24.

International Congress on Semiconductor Physics, sponsored by the AF Office of Scientific Research, NSF, ONR and the International Union of Pure and Applied Physics, Paris, July 20-24.

Meeting of the American Crystallographic Assoc., Montana State College, Bozeman, July 26-31.

Sixth International Symposium on the Reactivity of Solids, International Union of Biochemistry, New York Hilton and Americana Hotels, New York City, July 26-August 1.

"Random Processes in Communication Systems," Polytechnic Institute of Brooklyn's Farmingdale Graduate Center, Farmingdale, N.Y., July 27-31.

AUGUST

First Research Conference on Instrumentation Science, Instrument Society of America, Williams Smith College, Geneva, N.Y., August 3-7.

Fifth International Symposium on the Reactivity of Solids, International Union of Pure and Applied Chemistry and International Union of Pure and Applied Physics, Munich, Germany, August 4-10.

Performance of Government Contracts Conference, sponsored by Federal Publications, Inc., and the Government Contracts Management Assn., Plaza Hotel, New York City, August 6-7.

12th Annual Engineering Management Conference, Institute of Electrical and Electronics Engineers, ASME, AIIE, and ISA, Pick-Carter Hotel, Cleveland, Ohio, August 9-11.

Seventh National Heat Transfer Conference, American Institute of Chemical Engineers and American Society of Mechanical Engineers, Sheraton-Cleveland Hotel, Cleveland, Ohio, August 9-12.

Contracts Seminar, Department of Defense and the National Association of Professional Contract Administrators, Orlando, Fla., August 10-13.

Structural Developments in Inorganic Chemistry and their Chemical Implications, AF Office of Scientific Research, New Hampton, N.H., August 10-14.

Thirteenth Annual Conference of Applications of X-Ray Analysis, Metallurgy Div. of Denver Research Institute at the University of Denver, Albany Hotel, Denver, August 12-14.

1964 Cyrogenic Engineering Conference, University of Pennsylvania, Philadelphia, August 12-14.

Elementary Nuclear Magnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., August 17-19.

Tenth International Symposium on Combustion, Combustion Institute and Cambridge Physical Chemistry Dept., Cambridge University, Cambridge, England, August 17-21.

International Astronomical Union Symposium No. 25, AF Office of Scientific Research, International Astronomical Union, Government of Greece, and University of Thessaloniki, Thessaloniki, Greece, August 17-22.

Elementary Electron Paramagnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., August 19-21.

Conference on Interference and Coherence, International Commission for Optics and Australian Academy of Sciences, Sydney, Australia, August 24-25.

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, August 24-26.

Fourth Congress of the International Council of the Aeronautical Sciences, International Council of the Aeronautical Sciences and American Institute of Aeronautics and Astronautics, Paris, August 24-28.

Ninth Annual Technical Symposium, Society of Photo-optical Instrumentation Engineers and USAF Eastern Test Range, Deauville Hotel, Miami Beach, Fla., August 24-28.

"Graphic Techniques for Computation," sponsored by the University of California Extension Center, San Francisco, August 24 to Sept. 4.

Western Electronic Show and IEEE Summer General Meeting, Biltmore Hotel, Los Angeles, August 25-28

1964 International Congress for Logic, Methodology and Philosophy of Science, and International Colloquium on Algebraic Linguistics and Automata Theory, sponsored by AFOSR, AFCRL, ONR, ARO, and International Union for History and Philosophy of Science, Hebrew University, Jerusalem, Israel, August 26-Sept. 2.

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Two Minds

THERE IS LITTLE DOUBT in anyone's mind what the election of Sen. Barry Goldwater to the Presidency of the United States would do for the defense business. There might indeed be a brisk new market in fallout shelters.

But the current Administration has done little to settle its self-created confusion about what the industry's future will be if President Johnson continues in office.

His support for the space program has been active and strong ever since he took office as Vice President and became chairman of the National Aeronautics and Space Council. But President Johnson and his Secretary of Defense have done precious little to assure this industry that it can base its long-range planning on a continuing and large defense market.

There is considerable evidence to the contrary in the death of the Pluto program for a nuclear ramjet *Low-Altitude Supersonic Vehicle*. The refusal to carry a promising and technically successful project into the flight-test stage negates all the flowery phrases about technological building blocks which Mr. Robert McNamara and his lieutenants have showered upon us the past four years.

Dept. of Defense spokesmen refuse to discuss cancellation of the program, which has yet to be announced. They apparently hoped that a secret label on the death blow to the project would avoid the embarrassment of having to explain it publicly. Well they might, since the nuclear ramjet was cancelled on very nebulous grounds at a time when there was little question about its technical feasibility.

The cancellation, with its undertones of unilateral non-armament, is of broader significance than the program itself. If we continue to appease the Soviet Union by failing to carry out research and development in promising areas, then it must be asked whether there is, in fact, a bright future for defense firms.

The Administration speaks with two minds on the subject. We reported on July 6 the talk by Dr. Eugene Fubini, deputy director, Defense Research & Engineering, in which he criticized those who are unoptimistic about the future of the defense industry.

He complains that industry analysts have extrapolated a very small decrease in the defense budget into very large cuts in the future.

"I see symposia planned on conversion from defense into commercial enterprises," he says. "All this gloom and doom talk from a 5 percent decrease in defense spending!"

Mr. Fubini may not think very highly of these symposia, but we are confronted by the confusing spectacle of another DOD official very actively engaged in them.

As a matter of fact, the symposia—such as the one in Boston in May (M/R, June 1, p. 21) and the American Management Association meeting in New York last week (see p. 15)—have begun to take on as predictable a cast of players as a repertory group.

Current circuit favorites are Arthur Barber, Deputy Assistant Secretary of Defense for Arms Control, and Archibald S. Alexander, Assistant Director of the U.S. Arms Control and Disarmament Agency.

Arthur and Archibald may soon rival Chet and David or Ev and Charlie as a popular pair in the public eye.

Any carefully selected conversion roster will have on it, in addition to this chatty duo, one or two other speakers from peaceful planning divisions of the Atomic Energy Commission and the National Aeronautics and Space Administration.

Then, enter stage left the representatives of major industry firms whose main hope is that they can convince other firms to bail out of the industry.

Haunting every meeting and paper like a wind-grieved ghost is the spectre of former Deputy Secretary of Defense Roswell Gilpatric, whose much-publicized article in *Foreign Affairs* predicting a wholesale cut in defense spending is well on its way to becoming the most obvious trial balloon ever floated from the Pentagon.

To round out the cast, there is usually a Wall Street analyst ("buy now at depressed prices") and an academician or two to take note of the manpower drain inflicted by defense on other important social undertakings.

THE OVERRIDING PROBLEM with the meetings is the rarity with which facts are presented. Facts are what the industry executive needs for long-range planning.

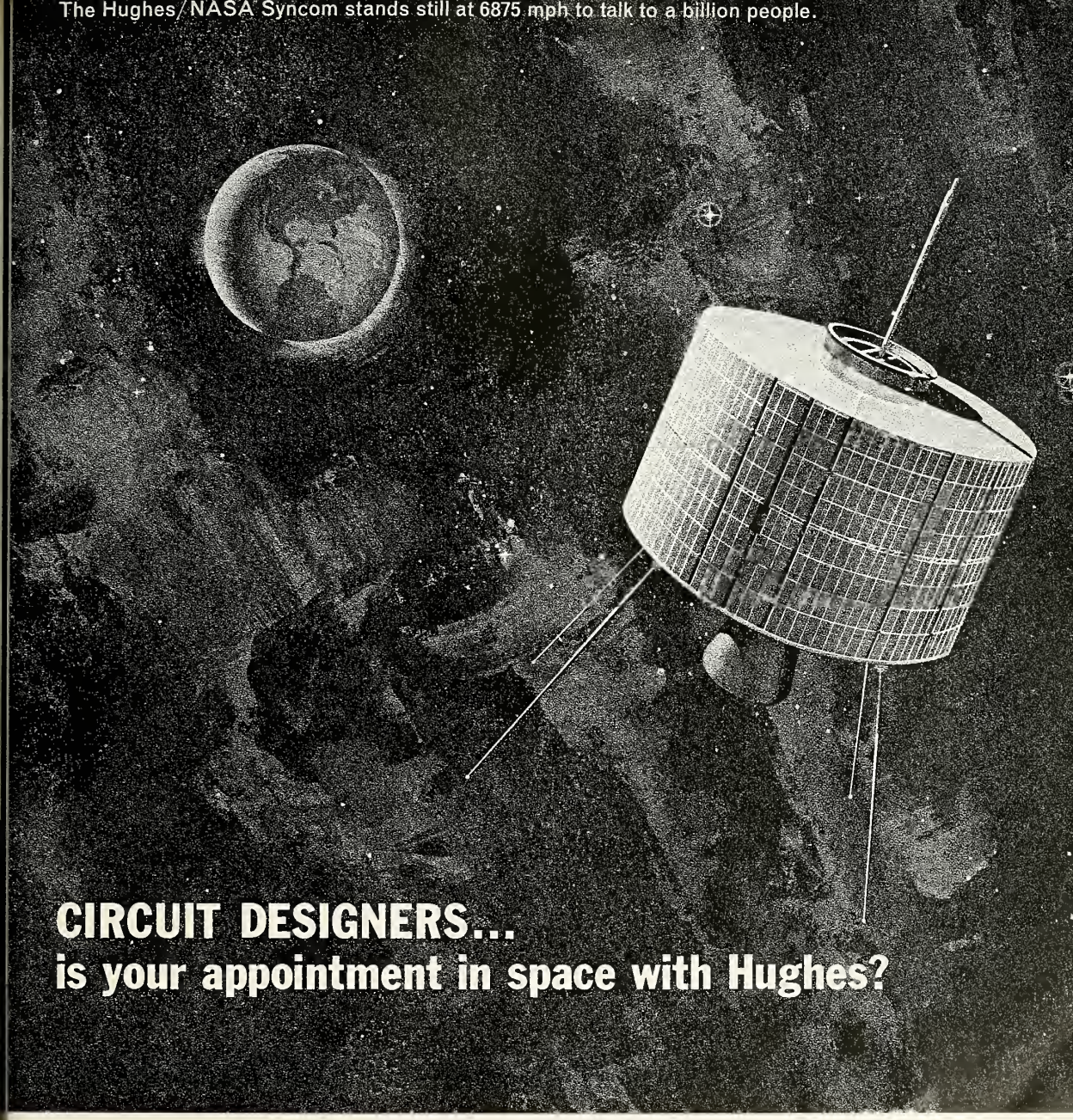
Yet the topic of defense is almost always left up to representatives from the defense industry, who are as confused about the future as their colleagues in the audience, who sit hopefully through the whole playlet in a vain effort to learn something worthwhile.

The government speakers, however, confine themselves to broad and sweeping generalizations about large projects in public health, medicine and mass transport in which the defense industry can take part in the future. Representatives from such agencies as the National Institutes of Health or the Dept. of Interior who might be presumed to have details on such programs are conspicuous by their absence.

Upon returning from such a symposium, the industry executive then can read that Dr. Fubini has said: "I want to state clearly my convinction that the research and development budget of the Dept. of Defense in the forthcoming years will not change a great deal . . . My prediction on future R&D budgets is one that many high elements of the Dept. of Defense share."

We suggest that Dr. Fubini, Mr. Barber, Mr. McNamara and all those other high elements of DOD get together with President Johnson and decide just what the future of this industry is. If Dr. Fubini is correct, then they should cancel all the conversion symposia, shoot down the Gilpatric trial balloon and get on with the job. Re-institution of the *LASV* program would be a good place to start.

William J. Coughlin



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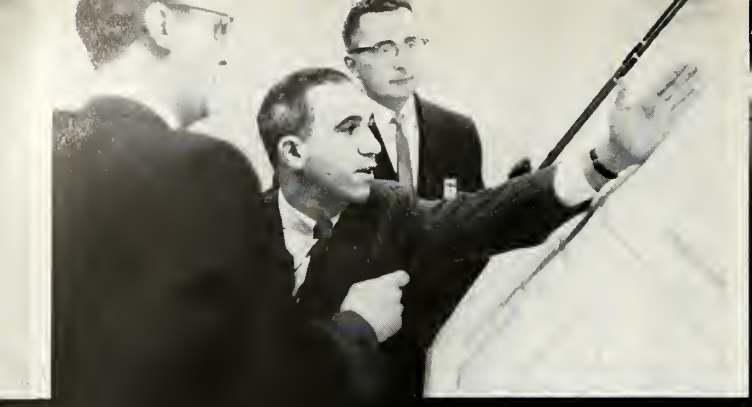
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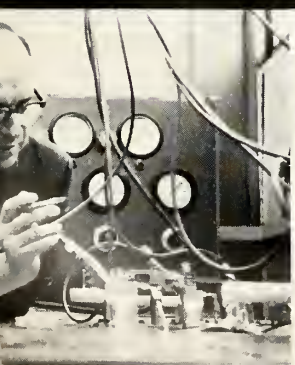


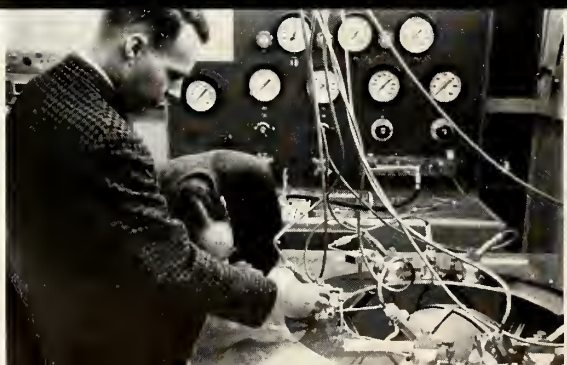
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JULY 27, 1964

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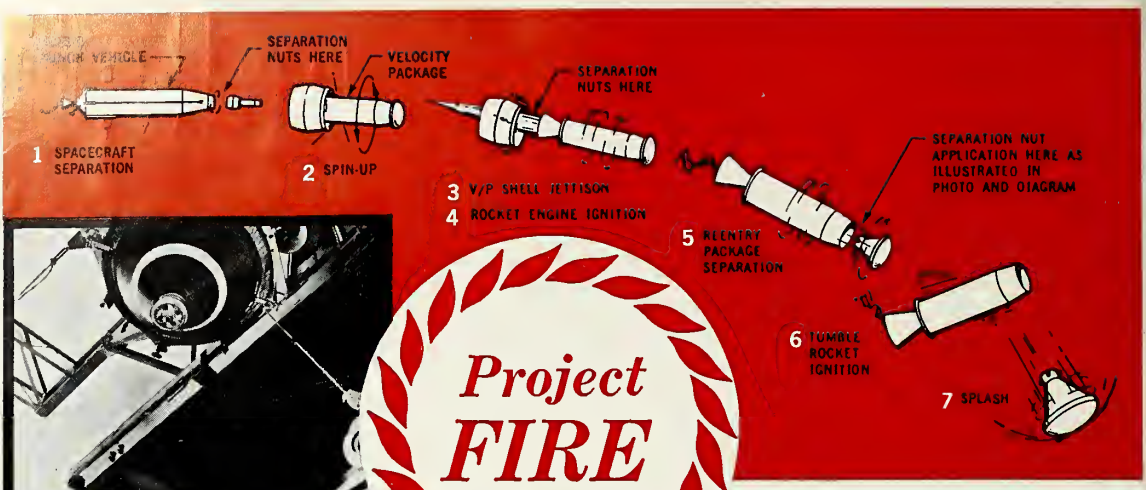
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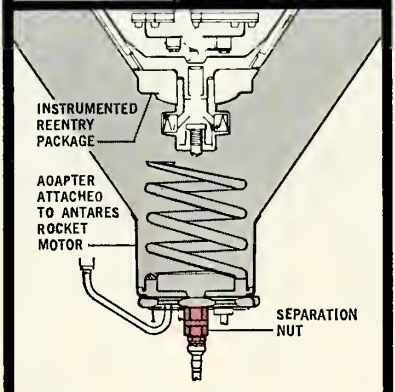
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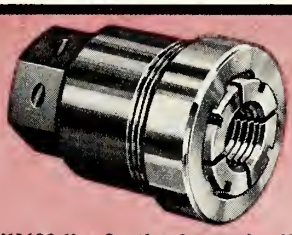
Project FIRE

DEMONSTRATES RELIABILITY OF HI-SHEAR'S SEPARATION NUTS

Scene showing Project FIRE spacecraft being lowered for mating to reentry package adaptor.



After release of Separation Nut from stud, coil spring expands to separate the reentry package from adaptor that remains attached to Antares rocket motor case.



SN2100 Non-Captive Separation Nut
Meets space environments including corrosive atmospheres—offers advantages of lightness of weight and compactness in size—capable of exceeding full torque and tension loads of a standard MS internal wrenching bolt heat treated to 160,000—180,000 psi ultimate tensile strength—standard sizes from ¼—¾ diameter, larger sizes on request—other material configurations available.

After 1640.2 seconds and 4958 miles from launch and at a velocity of 25,426 mph, the last of eight SN2100 Separation Nuts used during stage separation released a heavily instrumented, 200-pound, Apollo-shaped spacecraft on a ballistic trajectory to obtain for the first time direct measurements of reentry heating ... at a velocity comparable to that attained by a vehicle entering the Earth's atmosphere after a journey to the Moon.

Project FIRE is a research investigation by Langley Research Center, under direction of NASA's Office of Advanced Research and Technology. The spacecraft reentry package developed by Republic Aviation Corporation and the velocity package built by Ling-Temco-Vought, Astronautics Division, both used SN2100 Separation Nuts in non-redundant applications.

Project FIRE once more demonstrates the reliability of Hi-Shear developed separation systems. Already, thousands of fully qualified SN2100 Separation Nuts, used with Hi-Shear's PC Series Power Cartridges, have been fired by customers without a reported failure. This historic success predicts a reliability well above .999 at a 95% confidence level. Hi-Shear's PC Series Power Cartridges meet or exceed the requirements of AFMTCP 80-2.

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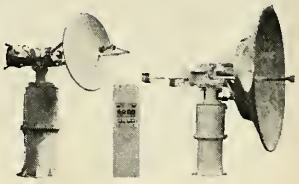
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GLOBAL RADAR TRACKING SYSTEM

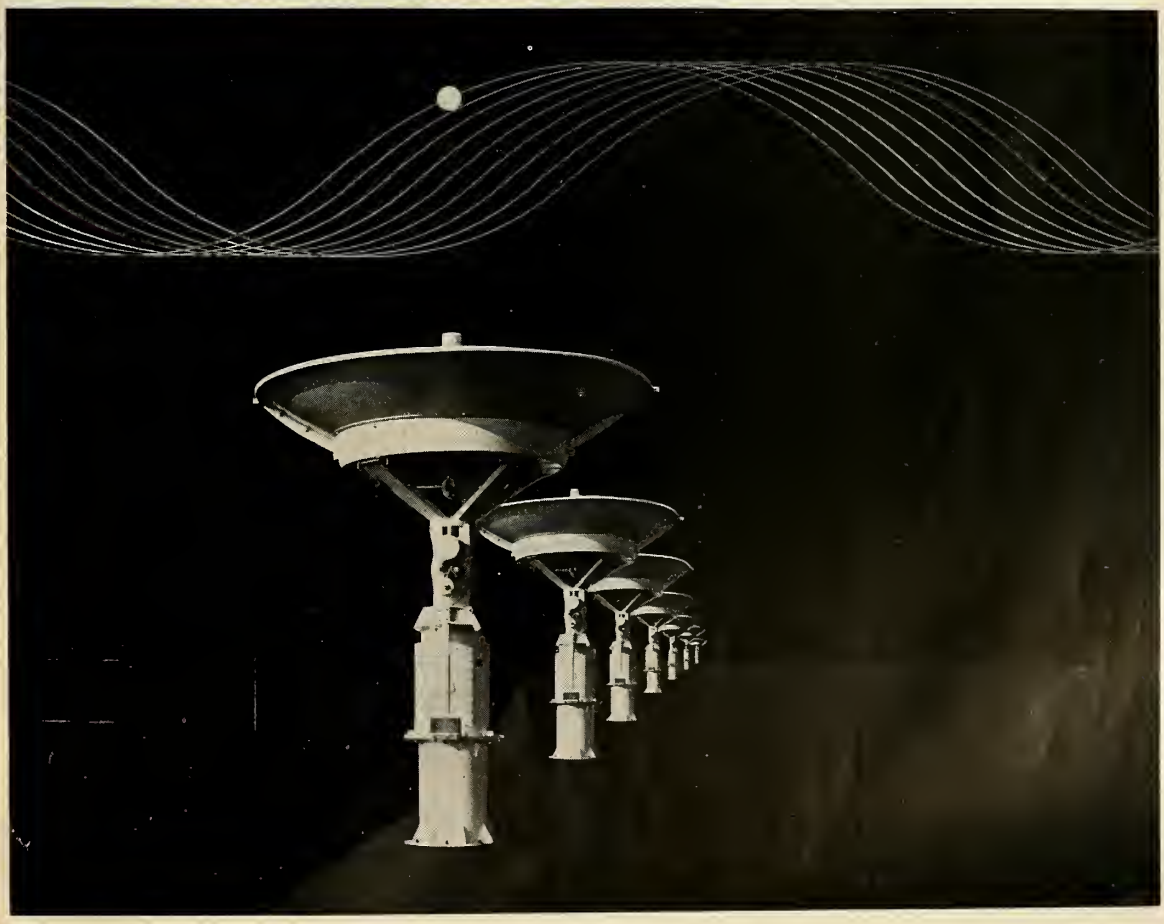
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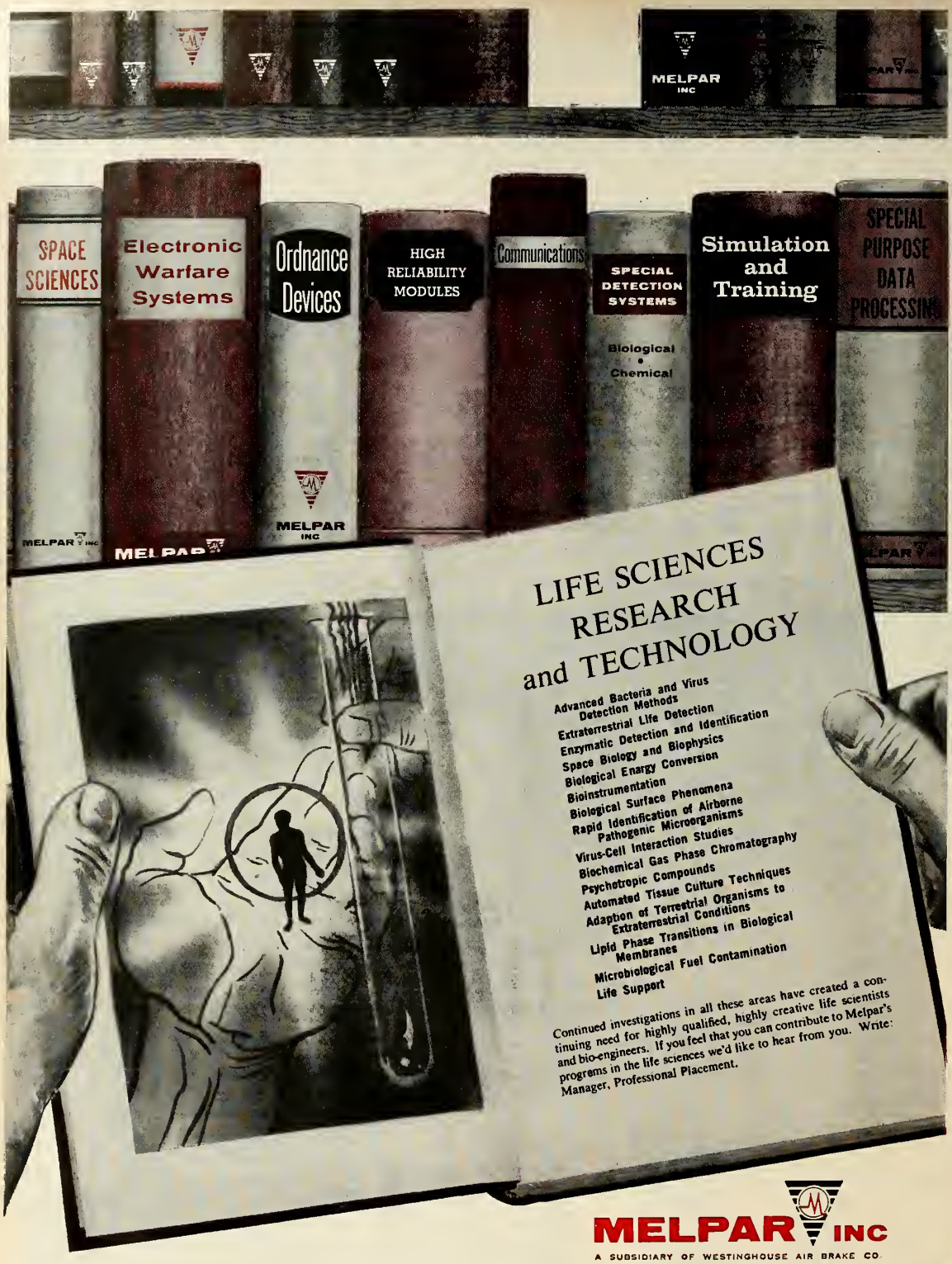


Write for details of GLOTRAC antennas and other tracking systems capability at Canoga. (Career opportunities for engineers; Canoga is an equal opportunity employer.)

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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 15, Number 4 July 27, 1964

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THE COVER



First unmanned launch of Gemini-Titan II lifts off from Complex 19 at Cape Kennedy last April 8, ushering in the "second generation" of manned space flight for the U.S. The Gemini and Titan systems are featured in MISSILES AND ROCKET'S *Eighth Annual World Missile/Space Encyclopedia, an exhaustive compilation of U.S. and foreign missiles and space systems.*

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MISSILES AND ROCKETS' EIGHTH ANNUAL WORLD MISSILE/SPACE ENCYCLOPEDIA 39

Compiled under direction of Assoc. Editor James Trainor

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57,800 copies this issue



They gave us a big assignment

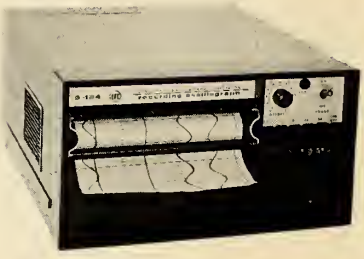
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Sensors and Pickups



Chart shows the 43 available for pressure, vibration, acceleration.

Signal Conditioners

Chart shows 11 basic types and where they may be required.





Magnetic Tape

Chart shows 8 analog and digital recorder/reproducers with support equipment.

Direct Readout



Chart shows 5 recording oscillographs, 33 galvanometers and where they can be used. Also support equipment.

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letters

Why Organized Inventors?

To the Editor:

In reply to Harry Bricker Fuchs (Letters, July 13, p. 6), my contention was that independent and employed inventors in the U.S. must organize for *protection*. I did not mean to imply that they should organize for invention. We assume that they can individually manage their inventive activities though harassed by enforced employee-assignment agreements, the high cost of patenting and the increasing financial starvation of the U.S. Patent Office, which results generally in a lag of one or more years between application for and award of a patent.

As for loyalty: The rules of our free-enterprise economy require that entrepreneurs seek out the best market for their (non-strategic) products. Hence it is manifestly in the best interest of our way of life that individual U.S. inventors take their non-strategic ideas to Europe, where incentives to invention commensurate with the pre-employee-assignment-agreement era in our own nation are widespread. Like the world problems desperately in need of the inventor's attention—viz., poverty, disease, housing, transportation, water, power and conservation, to name only a few of the most important—the education of the inventor is the legacy of all nations, races and times.

John H. Bloomer
Manhattan Beach, Calif.

Compliments

To the Editor:

As a subscriber to MISSILES AND ROCKETS for the past eight years, I would like to compliment you on an excellent reporting job. I also appreciate the segregating and compacting of information into as few pages as possible so that they may be easily clipped and filed.

Edward H. Yates
Defense Research Corporation
Santa Barbara, Calif.

Clustering Consumables

To the Editor:

The disadvantages of combustible rocket motor cases (M/R, June 22, p. 31) would not be present with consumable cases if the motors were of such a size that the wall thickness needed to contain the pressure were just equal to the distance the fire would burn during the ascent into orbit. This could easily be brought about by clustering—a feature having other advantages also, such as better mixing of the combustion gases. Mylar polyester walls 1 in. thick with tensile strength of 20,000 lbs./in.^{2} should contain 10-atm. pressure in a 20-ft. motor with narrow safety factor or 15-ft. motor with good margin barring pressure surges, which latter could be greatly reduced by use of surge-chambers.

Having the oxidizer tanks inside the motor and utilizing the natural boil-off would enormously simplify the propulsion system, permitting location of the oxidizer at points where it is needed, and the partially filled tanks would act as surge-chambers—also as baffle-plates to promote better mixing if located so as to partially obstruct the flow of gases. And the decrease of pressure to match the burn-through of the motor case would occur automatically with emptying of the tanks. Some experiments indicate that efficiency may be maintained down to very low pressures (A.S.M.E. *Transactions*, July, 1955, p. 610).

Inclusion of liquid hydrogen tanks would increase the specific impulse and at the same time freeze the oxidizer to temperatures too low for explosions. (Anti-oxidant coatings and inert-gas barriers would give added protection. And the low conductivity and good performance at cryogenic temperatures make thermal wood and plastic promising materials.) Inclusion of volatile fuels in hybrid motors is coming into increasing favor. And the method here suggested would render the difficult fuels such as hydrogen as easy to handle as any others. The same would be true of oxidizers such as fluorine. And the averaging-out effect of many small tanks would make for stability regardless of the nature of the propellants.

Even uniform burn-through should not prove an insoluble problem with multiple reflecting walls cooled by hydrogen boil-off from auxiliary tanks for the final, outermost portions of the motor casing. The elimination of staging possible through such controlled attrition merits the most careful attention and experimentation.

Theodore B. Dufur
Los Angeles, Calif.

Phoebus Relocated

To the Editor:

Regarding a small item about Phoebus appearing on page 7 of the July 6 M/R—these reactors will be tested at the Nuclear Rocket Development Station in Nevada, *not* at White Sands Missile Range, N.M.

Phoebus design and development work is taking place here at the Los Alamos Scientific Laboratory in New Mexico, some 250 miles north of White Sands.

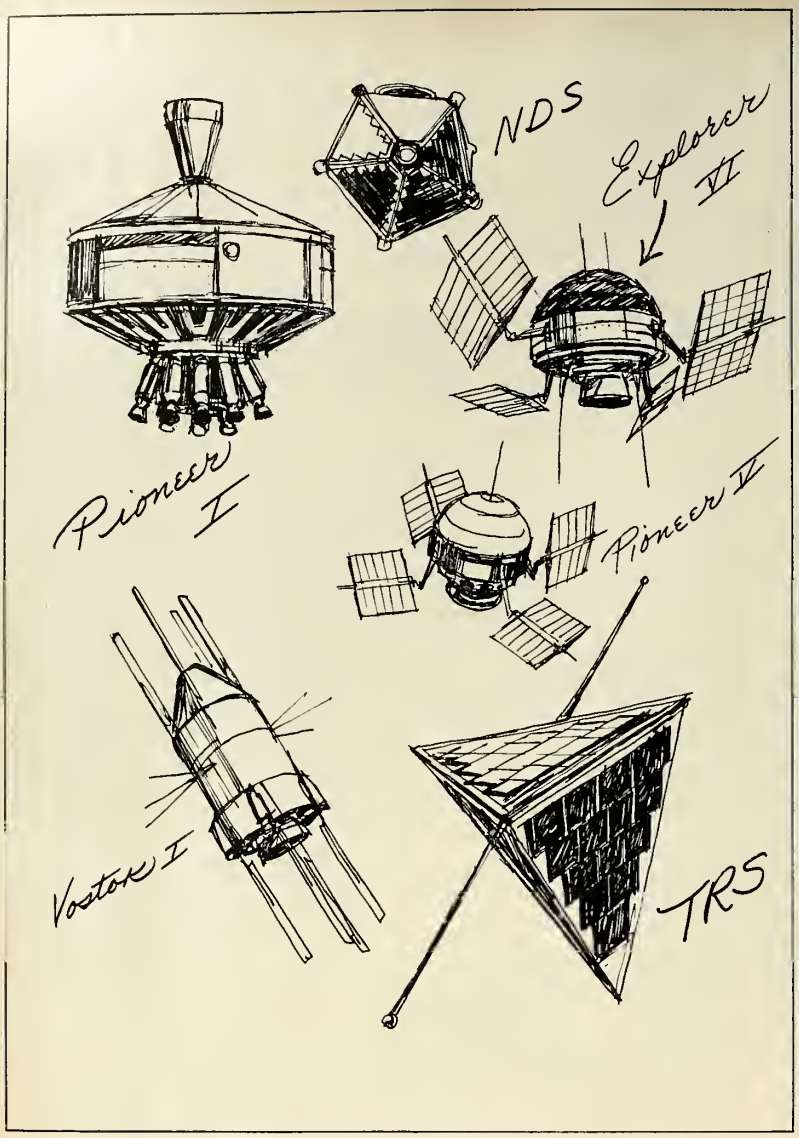
Peter Mygatt
Public Relations Office
University of California
Los Alamos Scientific Laboratory
Los Alamos, N. M.

Campaign Assignment

To the Editor:

Please work to keep *both* sides honest on defense during the election campaign—sparing neither unfair charges by the GOP nor phoney Administration replies.

Ray Kleinberg
Kansas City, Mo.





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Spacecraft above: Pioneer I, lunar probe, launched Oct. 1958; Explorer VI, scientific satellite, launched Aug. 1959; Pioneer V, interplanetary probe, launched March 1960; TRS, tetrahedral research satellite, launched 1962; NDS, nuclear detection satellite, launched 1963; Vostok I, manned Russian spacecraft, launched April 1961.

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The Countdown

WASHINGTON

Congress Probing LASV/Pluto

The Joint (Congressional) Atomic Energy Committee has scheduled hearings this week on the Pentagon decision to cancel the *Low-Altitude Supersonic Vehicle (LASV)*/ Pluto program. Committee members are expected to hear testimony from Director of Defense Research & Engineering Dr. Harold Brown and Air Force and AEC officials.

New DOD Official To Inspect Readiness

One of the duties of the newly created position of Assistant Secretary of Defense for Organization and Management is to inspect the operational readiness of combat forces—formerly an exclusive function of the Joint Chiefs of Staff. Reason for the change, says Defense Secretary McNamara, is that "readiness of units has been overstated" in the past and he wants a direct means of assessing such posture.

NASA Tells of New FY '66 Priorities

It's just been disclosed that NASA sent a letter to the Bureau of the Budget on May 1 listing the projects on which it wants to make new starts in the Fiscal 1966 budget. Included were the *Extended Apollo*, LEM truck vehicle, and *Voyager* Mars exploration spacecraft. While the space agency officially maintains that there will be no requests for heavy development funding for manned spaceflight projects, it is expected that funding necessary for program definition and detailed design may be approved.

Air Force MMRBM Maneuvering

A last-ditch campaign by the Air Force and its contractors is under way to elicit some support in Congress for the *Mobile Medium Range Ballistic Missile (MMRBM)*. A back-door effort, whose connection with DOD is unclear, it involves feeling out members of Congress before the Democratic convention to see how receptive they are to an *MMRBM* reprogramming request. Observers think a more fruitful approach might be to present a *raison d'etre* for the system.

Pump Tests Slipping Next Centaur

Fourth launch of the *Centaur* vehicle has now slipped from September to October, though the first stage of *Centaur AC-4* arrived at Cape Kennedy last week and the *Centaur* stage is due this week. Officials blame the hydraulic pump for the failure of *Centaur AC-3* to achieve orbit. The pump is being beefed up to prevent a recurrence of the problem, but tests of the unit are forcing the month's delay.

Apollo Transporter Truck Advances

First successful test of the truck that will power the crawler-transporter used to move the *Apollo* spacecraft and its *Saturn V* booster to the launch pad was conducted on July 13. Prime contractor for the vehicle is the Marion Power Shovel Co., which ran the test.

Maintenance May Be Atlas Blast Culprit

Senate Preparedness Subcommittee investigations of the *Atlas F* explosions during the past year may come to the conclusion that "poor maintenance" was responsible for most of the failures. In one case, at Walker AFB, N.Y., oil was left in the bottom of the silo where combustion-supporting LOX could cause trouble.

Small-Business Hocus-Pocus

NASA, trying to project a favorable public image, was caught recently playing a somewhat devious numbers game. It announced proudly that 74% of its subcontracts in the first nine months of Fiscal 1964 went to small business. The data were obtained from 12 prime contractors and their first-tier subcontractors. What the agency neglected to say was that these first-tier firms, which were not included in figuring the small-business percentage, totaled 1,051. Since only a few of the first-tier companies are small businesses, including them in the total of subcontracts awarded in that period brings the small-business share to only about 37%. In dollar terms, the percentage drops further—from 23% down to 10-12%.

Not Another One!

As if the world didn't have enough management information systems, the Air Force Systems Command has developed "an improved research contract management technique." Bearing some similarities to the granddaddy of them all—PERT—the new system relates scientific and technical portions of the proposed research work to time and cost—"thus providing a tool for early identification and solution of procurement and technical problems." Which sounds awfully familiar.

INDUSTRY

AMF Briefs SAC on Advance Bases

Members of AMF's Field Operations and Engineering Div. recently briefed representatives of the Strategic Air Command's Planning and Programs Div. on the company's concepts for advanced basing facilities for ballistic missiles. Primary emphasis was on achieving survivable and quick-reacting launch bases. Stress was also laid on ground mobility, air-transportability and modification of existing facilities to house heavier-payload missiles.

Aeronutronic Wins Mars Laboratory Study

Aeronutronic has been selected by NASA to conduct a one-year study of an Automated Biological Laboratory, which will be part of the payload of the *Voyager* Mars exploration spacecraft. Under the contract, to be worth about $300,000, the company will study a laboratory to be used to detect extraterrestrial life.

INTERNATIONAL

French Electronics Firms Concentrate

Compagnie Générale d'Electricité (CGE) and Compagnie Générale de Télégraphie sans Fil (CSF) recently concluded an agreement to create a joint branch firm to develop industrial and scientific computers. Almost immediately there was an announcement from CSF that it would also form a joint company with La Compagnie Française Thomson-Houston. The latter new venture will develop and produce tracking and telemetry stations for the French space program.

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GT-2 Slips to 4th Quarter

The second unmanned launch in the *Gemini* manned space flight program has now slipped into the fourth quarter of the year—thus killing all hope of a U.S. manned space flight in 1964.

A NASA spokesman told MISSILES AND ROCKETS that the official new launch date of *GT-2* was now early in October. Previously, the space agency schedule called for the unmanned ballistic shot to be attempted in July.

Wiliam Schneider, acting director of the program at NASA headquarters, said that there is no major technical problem or anything basically wrong with the program. "It was initially set up on a success schedule," he said, and "when a small part fails in a vibration test, it takes time to fix it, and this causes some delay."

While NASA officially maintains that the first *Gemini* manned shot is still scheduled for this year, the *GT-2* slippage makes it almost impossible.

With little more than two months remaining to get the *GT-3* shot off, informed sources reported that it would not be enough time to clean up the *Titan II* pad and do the necessary checkout and testing prior to launch. It is also felt that there will probably be further technical and weather holds in the second flight's schedule. The sources said that the most likely date for the manned flight is now February or March of next year.

It is expected that the spacecraft for *GT-2* will be delivered to Cape Kennedy next month.

The *Titan II* launch vehicle for *GT-2* arrived there July 14. The *Titan's* two stages were flown in an Air Force C-133B cargo plane from Martin Company's Baltimore plant, where the launch vehicle was assembled and is being tested under an Air Force Space Systems Division contract.

Several weeks of intensive systems tests and checkout will be performed by Martin Company engineers before the two-man spacecraft is hoisted aboard the *Titan's* second stage.

The two will undergo a checkout program which includes a joint combined systems test; a "wet mock" exercise, when the *Titan* will be fully fueled for a practice countdown and simulated powered flight; and then a full-scale simulated flight tied in with the range tracking system and the spacecraft recovery fleet of planes and ships in the planned landing area about 2,000 miles southeast of Cape Kennedy.

The first *Gemini* flight April 8 was a complete success. The *Titan II* rocket lifted off its Complex 19 pad after a perfect, no-hold, five-hour countdown. The partially instrumented spacecraft and the second stage of the *Gemini-Titan II* achieved orbit attached together. They remained in orbit for about four days and five hours before re-entering the atmosphere and burning up.

Shillelagh Production Near

Philco Corp.'s Aeronutronic Div. plans to begin mass production of the Army's *Shillelagh* missile "in the near future," according to an announcement made public by the division July 27.

Production of the missile will take place in a 205,000-sq.-ft. facility in Lawndale, Calif., being turned over to the Army by the General Services Administration in the next two or three months. Aeronutronic will operate the plant.

Aeronutronic operation of the Lawndale facility is expected eventually to increase the company's payroll by 1,500 people, some to be hired late this year, but the majority not until the latter part of 1965 and early 1966.

The *Shillelagh* system incorporates a General Sheridan armored reconnaissance vehicle as a mobile launcher. A command system mounted on the launching vehicle guides the missile to its target.

The Sheridan/*Shillelagh* is the first American fighting land vehicle designed to fire a missile. The Sheri-

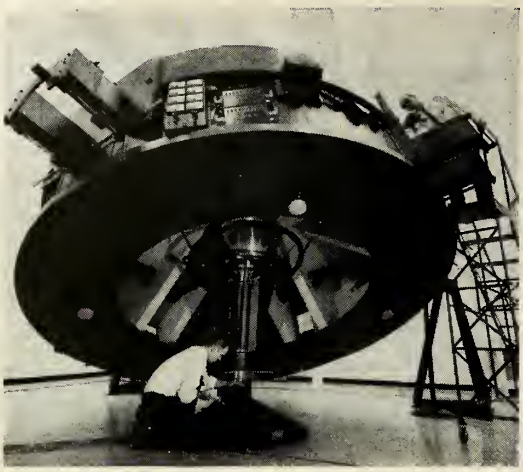




Titan Family Gathers at Cape Kennedy

LEFT. The two stages of the Gemini-Titan II launch vehicle to be used in the second unmanned Project Gemini suborbital flight (GT-2) are shown upon arrival for testing and checkout at Cape Kennedy. Booster was flown in an Air Force C-133B from Martin Co.'s Baltimore plant, where it was built. RIGHT: Martin also builds the Titan III-A, the three sections of which are shown arriving at the Cape. The Air Force standard space launch vehicle will make its maiden orbital flight later this year, the first of 17 development test flights scheduled to show the vehicle's varied capabilities. First III-A was assembled on a test stand last week.

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Deflections and loads are sensitively balanced by the Hexcel design resulting in minimum overall distortion.

Thick core slabs of honeycomb (in various densities) were assembled in pie sections, sawed in the round, machined to dimensional accuracy, then bonded en masse to surface skins at room temperature using a cold-bonding process.

Hexcel R & D, under contract to Minneapolis-Honeywell, was responsible for the design, honeycomb manufacture and platform fabrication direction. Delivery was on time. Actual maximum edge deflection of the platform is .0029 in., exceeding specification.

The Hexcel objective is both to manufacture the widest range of honeycomb core products available, and to provide solutions to unusual high strength-light weight structural problems.

HEXCEL'S DESIGN OUTPERFORMS ALL OTHERS (This chart compares an earlier Hexcel Design. The platform was smaller but for the same purpose as the work discussed above.)

	Company A Design	Company B Design	Company C Design	Hexcel Design
Platform	Riveted Aluminum	Welded Mild Steel	Welded Stainless Steel	Alum. Sandwich Construction
Platform Weight	—	—	—	406 lbs.
Table Inertia Capacity	20-40 Slug Ft² Max.	26 Slug Ft² Pitch 33 Slug Ft² Roll 14 Slug Ft² Yaw	65 Slug Ft² Pitch 65 Slug Ft² Roll 33 Slug Ft² Yaw	126 Slug Ft² Pitch 126 Slug Ft² Roll 210 Slug Ft² Yaw
Max. Load Capacity	400 lbs.	1100 lbs.	900 lbs.	4000 lbs.
Deflection at Max. Load	—	½"-1"	—	.0007"-.0016"

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Plants: Berkeley, Oakland, Calif.; Havre de Grace, Md.; Irving, Texas
Sales Offices: Inglewood Calif.; Havre de Grace, Md.; Irving, Texas

dan's 152-mm gun-launcher is also capable of firing conventional ammunition. The missile offers considerably increased firepower for use against armor, troops, and field fortifications.

MSFC Awards 29 Studies

NASA's Marshall Space Flight Center has announced the award of 29 study contracts spread among 13 missile/space firms, with the Boeing Co. heading the list with total awards of $2.2 million.

Total value of the contracts is $8 million. Other firms, according to the monetary value of their contracts, are General Dynamics, $1.3 million; Lockheed Missiles & Space Co., $1.06 million; Bendix, $800,000; North American Aviation, $467,250; Douglas Aircraft Co., $308,500; TRW Space Technology Laboratories Inc., $249,970; Bell Aerosystems, $199,333; Ling-Tempco-Vought, $197,950; Chrysler, $170,000; The Martin Co., $147,154; and Westinghouse, $81,656.

In addition, NASA is negotiating with two other firms for two other studies and will begin negotiations soon on a third contract.

A detailed breakdown of the contracts and subjects covered includes:

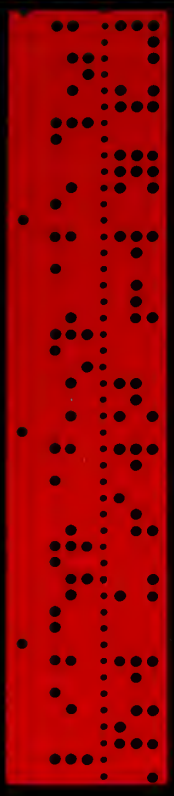
—*Saturn IB*—Chrysler Corp. ($170,000) will consider aspects of a liquid-propellant first stage with "boost assist." Douglas Aircraft Co. ($99,000) will investigate aspects of a solid-propellant first stage.

—*Saturn V*—The Boeing Company ($215,240), North American Aviation, Inc. ($217,250), and Douglas ($209,500) awards are for studies on the three stages to increase payload capacity. Boeing also will study "performance and control" ($245,570), solid applications ($277,500), and *Saturn V* booster re-usability ($195,640). Lockheed Missiles & Space Co. ($220,690) will undertake a 12-month study to develop design data for a cyrogenic tanker rocket to operate between low parking orbits and high departure orbits.

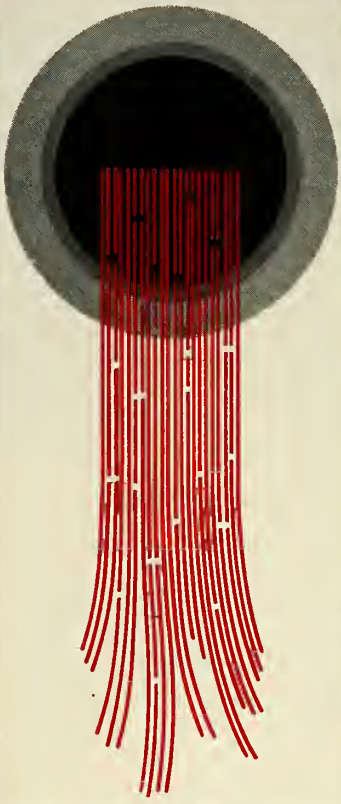
—Launch vehicle systems criteria —Boeing ($248,000) will consider "Projections from Historical Trends" and North American ($350,000) will study "Projections from Potential Trends."

—Launch vehicle cost studies—General Dynamics/Fort Worth ($138,000) for a "cost model," a mathematical representation of detailed costs. Lockheed ($138,640) will perform a component cost study. General Dynamics/Fort Worth ($96,980) and the Martin Co., Denver Division ($97,950) will make parallel studies of cost parameters.

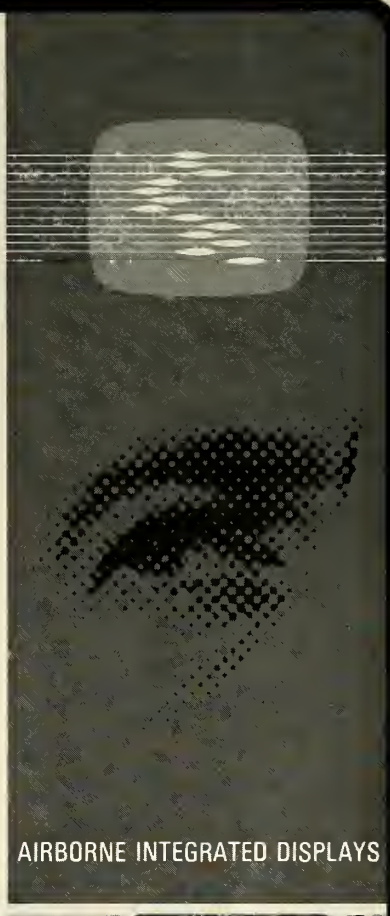
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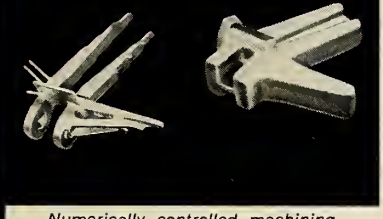
LARGE STRUCTURAL PARTS



SOLID FUEL ROCKET NOZZLES



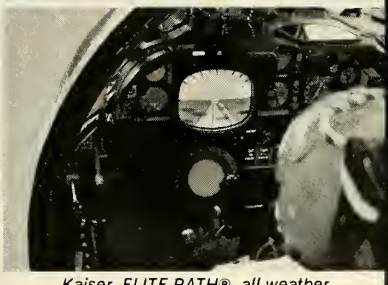
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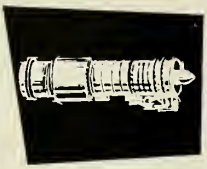
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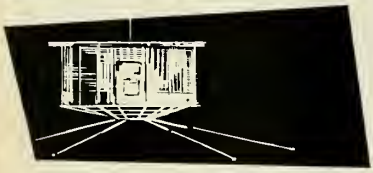
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—Re-usable orbital transport—Lockheed ($705,925) will consider aspects of the first stage, and General Dynamics/Astronautics ($492,300), the second stage.

—Earth orbital studies—A seven-month continuation of work on "Advanced Orbital Launch Operations," authorized by modification ($197,950) of an earlier contract will be conducted by Ling-Temco-Vought, Inc. Boeing ($150,000) will perform another study in the series "Orbital Launch Facility." A study called "Utilization of Spent Stages" is being negotiated with North American.

—*Apollo* Logistics Support System (ALSS) program—Boeing and the Bendix Corp. ($800,000 each) will make parallel studies of a mobile laboratory (MOLAB) to operate on the Moon surface.

In support of MOLAB, Bell Aerosystems Co. ($199,333) will study a "lunar hopper" for short flights to sites on the Moon unreachable afoot or in MOLAB.

Lunar Exploration System-*Apollo* (LESA)—A study of the necessary life-support systems will be negotiated with a company yet to be named. Westinghouse Electric Corp., Baltimore ($81,656) will study LESA communications and control requirements. General Dynamics/Fort Worth ($139,400) will study LESA operations and logistics.

Planetary studies—General Dynamics/Astronautics ($199,800) has a nine-month contract to study "Manned Mars-Venus Exploration." Negotiations are under way with Avco Corp. of a study entitled "Manned Mars Surface Operations."

In addition, GD/Fort Worth ($197,750) will study "Manned Planetary Mission Requirements;" TRW Space Technology Laboratories ($249,970) will study "Advanced Nuclear Systems Parameters;" and GD/A ($48,750) and the Martin Co. ($49,204) will make parallel studies of a "Planetary Transportation Model."

Navy Explores 3-T Replacement

The Navy is expected to award contracts soon aimed at replacing its *3-T (Terrier, Tartar* and *Talos)* surface-to-air missiles with an Advanced Surface Missile System.

Project definition phase 1 of the program, which will last five months, will be awarded to Boeing, General Electric, Hughes Aircraft, Radio Corp. of America, Raytheon, Sperry

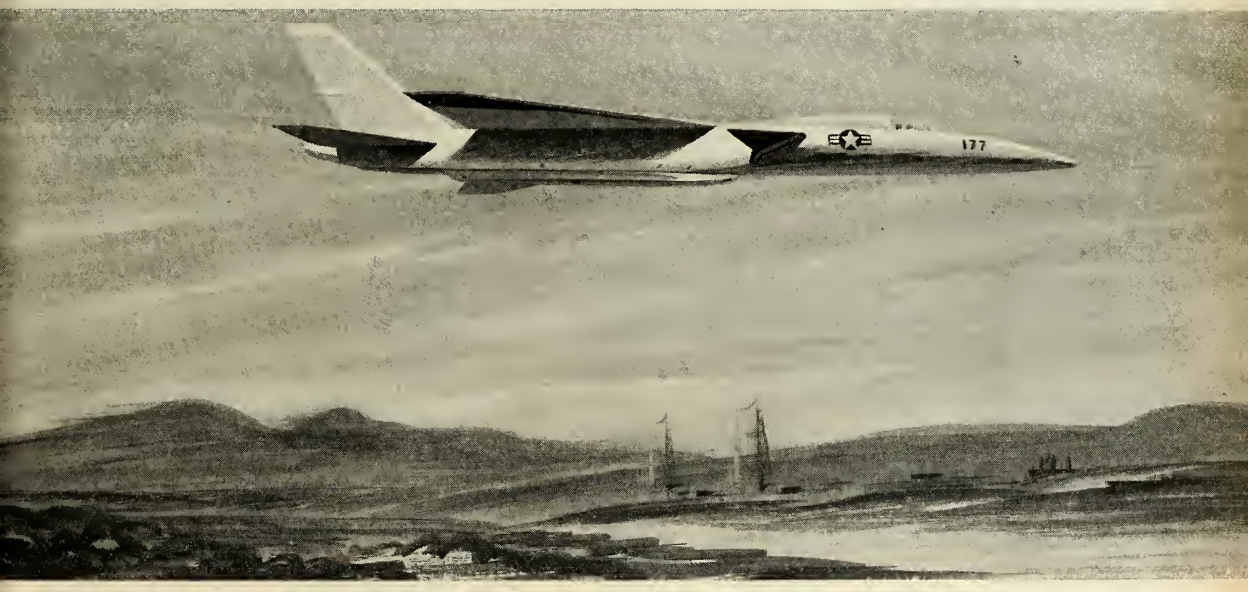


Nike-X Radar in Operation

FIRST PHOTO of Nike-X Multi-function Array Radar (MAR) shows the installation at White Sands Missile Range, N. M., undergoing design verification tests. In operation since July 1, MAR is the key element in developing an effective anti-ballistic missile system. The large concrete and steel domes house receiver and transmitter equipment. An inflatable fabric covers the "eyes" of the flat-plate receivers and transmitters. The small radar atop the dome is used for checkout purposes, while the beam-forming fence around the installation is designed to cut down on interference by radar reflected from ground.



8 years ago, Westinghouse radar made this picture through clouds over Baltimore



Now we can take a better look—faster, too

Install a side-looking mapping radar in a Mach 2 aircraft, flying "on the deck" over target areas. Acquire a detailed photographic record of every installation en route—regardless of light conditions, weather or visibility.

This is the capability of such radar systems as the AN/APD-7, now operational, and the AN/APQ-97 high resolution mapping radar Westinghouse is delivering to the military.

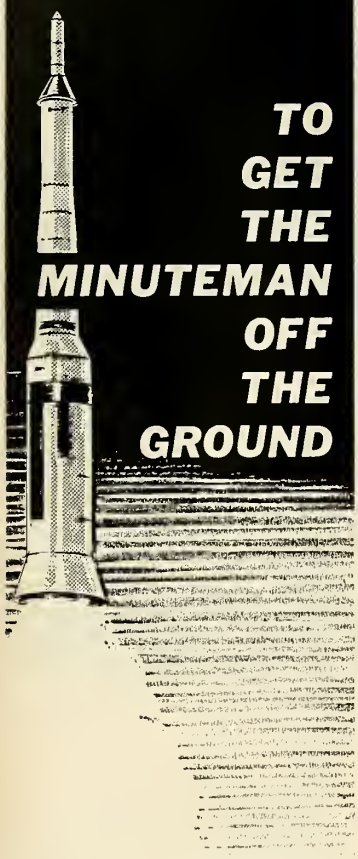
And we are continuing the design and development of high-resolution radars that are particularly suited to ground, air, and space missions. Our goal? To rival photographs in sharpness and detail even while penetrating darkness and cloud cover. Using sophisticated molecular electronic techniques we add another dimension—equipment that is smaller, lighter, and more reliable than ever.

Especially important is the management factor. At the Westinghouse Defense Center in Baltimore, the Aerospace Division applies broad management experience to all airborne and spaceborne projects. On-time delivery at the quoted cost gets equal emphasis with equipment performance. Value engineering, cost management, PERT, total product support—all are concepts Westinghouse has employed for years. This is the sound basis of Westinghouse leadership in electronics for defense and space systems. For further information, write Westinghouse Electric Corporation, Box 868, Pittsburgh, Penna. 15222. J-02360

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Rand and Westinghouse Electric, according to Pentagon sources.

The number of firms participating will be reduced to four when phase 2 of the work is awarded at a later time.

Operation target date for the new system is the 1970's.

Ranger VII Set to Go

The U.S. this week will make its seventh attempt to take television pictures of the Moon's surface with the *Ranger* lunar hardlanding spacecraft.

If it fails, as have the previous six flights, NASA will have two more opportunities with *Ranger* during 1965 before the *Surveyor* softlanding spacecraft is ready to make a picture-taking flight in 1966. The lack of lunar surface pictures—if it continues much longer—could put a severe cramp in planning for Project *Apollo*.

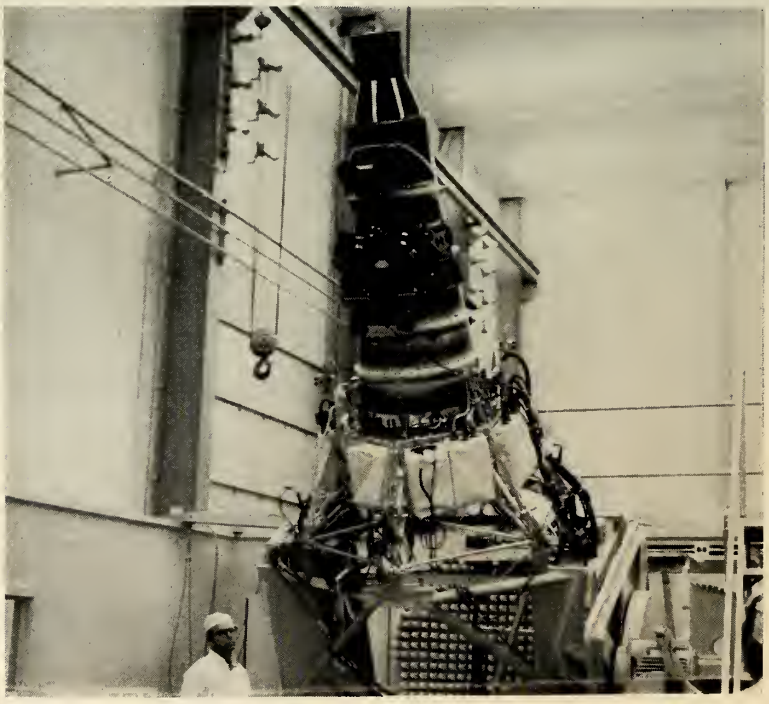
The *Ranger B* spacecraft is scheduled to be launched by an *Atlas-Agena* booster from Cape Kennedy during a six-day period beginning July 27. If the shot slips out of that launch window, another attempt could be made in September. No other launch attempts will be possible this year, however, because the two *Atlas-Agena* pads at Cape Kennedy will have to be prepared for the November *Mariner* spacecraft Mars fly-by missions.

The 806-lb. *Ranger* spacecraft will carry only one scientific experiment—six TV cameras. They are designed, in the 10 to 15 minutes just prior to impact, to provide several thousand pictures of the area of the Moon named the Sea of Tranquility.

The newest spacecraft has been sharply modified to prevent a recurrence of the problem which plagued *Ranger VI*, which hit the Moon on Feb. 20, 1964, but whose TV cameras failed to function.

After considerable analysis, the problem was pinpointed as high voltage electrical arcing during launch, which turned on the cameras prematurely, destroying parts of the transmitter and camera electronics.

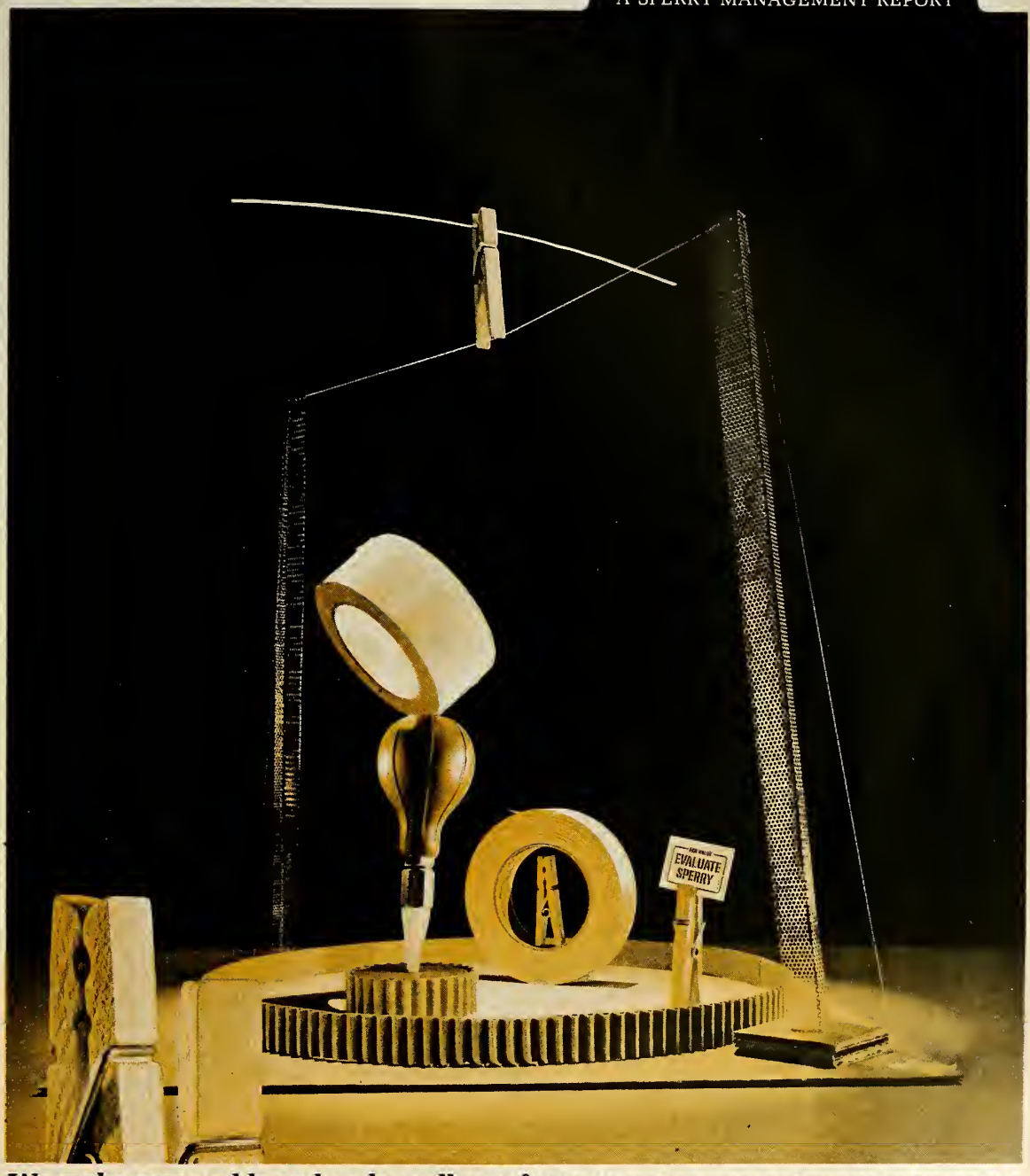
Space agency officials then decided to modify the spacecraft in a number of ways to cover several pos-



Ranger VII Readied for Launch

JPL ENGINEERS at A&M hangar, Cape Kennedy, assemble and check out six TV cameras in spacecraft. Two wide-angle and four narrow-angle vidicons are to begin taking video pictures of the lunar surface 10 min. before impact, and send the signals to tracking stations for recording on magnetic tape and reconversion to image on film. First images will be taken some 1,000 mi. from lunar surface.

A SPERRY MANAGEMENT REPORT



We make some odds and ends really perform. We took a syringe and invented a new way to remove excess solder—saved $25,000 a year in labor costs. A shrink-sleeving technique using a plain induction coil saved $50,000. Clothespins to hold coaxial cable marking tags—another $20,000. Cardboard+masking tape+perforated metal strips—presto!—a new kind of electrical wiring harness board saving $70,000 annually in direct costs. But the show has just begun. Look at Polaris; Sperry value engineering on navigation gear cut costs by $188 million. On the Sergeant missile, $30 million in direct costs saved. And this savings know-how is made available to others in industry. Sperry technical excellence backed by economies helps provide the best in defense equipment at lowest cost. **GENERAL OFFICES: Great Neck, N.Y.**

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* NASA proved, in the SA-6 launch, that Fondu-Fyre dry reflector can be used for multiple launches without in-between maintenance costs. Fondu-Fyre is a heat-resistant, high-strength concrete, highly resistant to thermal shock, for lining the flame deflectors of rocket engine test stands and missile launch pads.

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High ultimate strength—up to 5000 psi.
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sible causes of early turn-on of the television system.

The changes included redesign of the command control logic and circuitry, removal from the umbilical of a number of lines utilized for checkout of the television system during tests on the launch pad, lockout of the command circuit until after spacecraft separation from the *Agena* second stage and desensitizing of portions of the command circuitry.

Another major modification enables the television telemetry system to provide 90 points of telemetry over the spacecraft transmitter immediately at turn-on of either television system. In *Ranger VI*, the 90 points could be transmitted on the high power video transmitter only at full power operation.

In addition, the spacecraft's 15-point telemetry system will work from launch to impact instead of its limited functioning from spacecraft separation to impact in *Ranger VI*.

The *Ranger* spacecraft is managed by the Jet Propulsion Laboratory of California Institute of Technology. The hexagon-shaped spacecraft is 5 ft. in diameter at its base and 8¼ ft. high.

The TV camera system is built by RCA's Astro-Electronics Div. It is shaped like a truncated cone 59 in. high, 27 in. wide at the base and 16 in. wide on top, and is mounted on the base of the *Ranger* spacecraft bus. It is covered by a shroud of polished aluminum with a 13-in. opening near the top for the television cameras.

The 382-lb. television system consists of two wide-angle and four narrow-angle television cameras, camera sequencers, video combiners, telemetry system, transmitters and power supplies.

The cameras, which are located near the top of the television tower, are designated F (for full-scan) and P (for partial-scan) cameras. Of the two F cameras, one has a 25 mm lens with a speed of f/1 and a field of view of 25 degrees. The other camera has a 74 mm, f/2 lens with a field of 8.4 degrees.

Cameras P-1 and P-2 have 75 mm, f/2 lenses with 2.1-degree fields of view. P-3 and P-4 have 25 mm, f/1 lenses with 6.3-degree fields.

All the cameras have a fixed focus, but will be able to take pictures from about 1,100 mi. to within 0.5 mi. from the Moon's surface.

During each of the six days of the launch period, there is a launch window which varies from about 2.5 hrs. on the first day to about 1.5 hrs. on the last day. The window opens as early as 11:54 a.m. EDT on July 27 and, slipping a few minutes a day, opens about 2:19 p.m. EDT on the last day of the period, Aug. 1.

Flight time to the Moon will be about 68 hrs. depending on the launch date. The most desirable impact area will be an area 30 degrees above to 15 degrees below the lunar equator on the leading edge of the Moon and within 10 to 40 degrees of the shadow line or terminator.

Explosion Probe Under Way

One person—a powder worker—was hospitalized for observation in Cumberland, Md., but no injuries were reported after two explosions at Allegany Ballistics Laboratory, Rocket Center, W. Va., July 16.

The explosions occurred about 4 a.m. while no one was in the building, according to spokesmen for Hercules Powder Co., which operates the plant for the Navy.

An investigation is under way to determine the cause of the explosions, involving an X-259 upper stage and a HIBEX (High-G Boost Experiment) rocket motor.

SERT III Flight Test Seen

NASA will probably move to a flight test of its *SERT III* spacecraft following the first successful firing of an ion engine in space during the *SERT I* ballistic shot July 20 from Wallops Island, Va.

Dave Novik, director of the project at NASA Headquarters, said the other two possible flight projects—a repeat of the *SERT I* flight and a *SERT II* Earth orbital shot—are "doubtful."

He declared that while a final decision will not be made for weeks, data from the *SERT I* flight appeared to be of sufficient amount and quality to rule out a backup flight.

He added that the objective of the *SERT II* mission, long duration firing of an electric engine in Earth orbit, could probably be achieved in a ground test program.

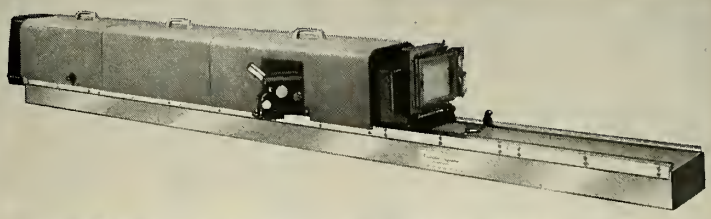
An evaluation of the *SERT III* spacecraft program is being made in Fiscal Year '65. This project calls for the firing of resisto-jet engines on attitude control and satellite station-keeping missions. It is expected that some funding will be available in FY '66 for the program.

In last week's flight, one of the two ion propulsion engines aboard the *SERT* (Space Electric Rocket Test) spacecraft was operated twice, for a total running time of 30 minutes. The engine was built by NASA's Lewis Research Center. A second ion engine, built by Hughes

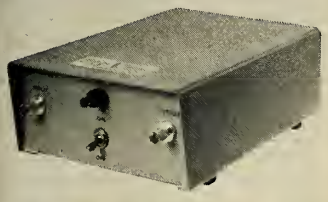
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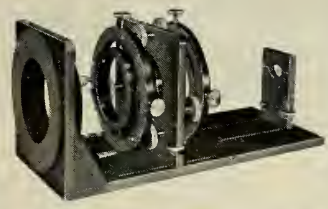
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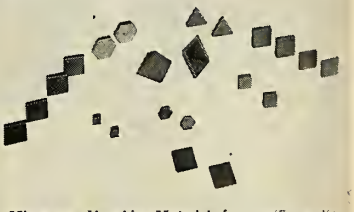
Optical Data Processors—from components to complete optical signal processing and analysis systems—with multi-channel capability, high density storage features. Configurations available for computations including frequency analysis, auto and cross correlation and two-dimensional spatial filtering for a wide variety of applications from missile vibration through geophysical prospecting.



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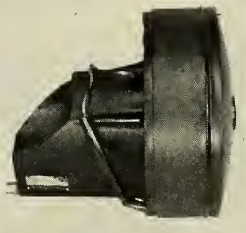
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- MAGNETIC AMPLIFIERS
- GUIDANCE AND CONTROL COMPONENTS

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Research Laboratories, did not produce thrust because of a suspected short circuit.

The *SERT* payload was lofted by a *Scout* rocket to a height of 2,500 miles before plunging into the Atlantic about 2,000 miles downrange from Wallops. The flight lasted approximately 50 minutes.

Raymond J. Rulis, *SERT* project manager of the Lewis Center, labeled the flight successful. "All our technical objectives were achieved," Rulis said.

The primary objective of the flight was to prove that ion electric engines, which produce thrust by accelerating a stream of positively charged particles, would work in space.

This could be accomplished only if the ion beams could be effectively neutralized in space. In the *SERT I* flight, this was achieved by injecting negatively charged particles into the exhaust. When the neutralizing beam was turned off, the engine stopped.

It is believed that if the space agency approves the *SERT II* and *III* projects, bids will be requested for a new spacecraft prime contractor. RCA is the prime for the *SERT I* spacecraft. The advanced projects, however, would require a heavier vehicle.

MITRE To Support BADGE

The MITRE Corp. has opened a branch office in Tokyo to provide technical support to the Japanese government on the BADGE program. BADGE, an acronym for Base Air Defense Ground Environment, will be developed and installed for Japan by Hughes Aircraft Co., the system prime contractor.

The U.S. Air Force's Electronic Systems Division, together with personnel from MITRE, ESD's associated not-for-profit firm, will serve as technical consultants to the program.

Ultimately, six engineering personnel from MITRE will be located in the Tokyo office for at least 18 months.

Syncom To Carry Olympics

Arrangements have been worked out for television transmission of the 1964 Olympics via *Syncom III*.

Scheduled for launch August 26, *Syncom III* will be positioned over the International Date Line in order to receive the transmissions from the Japanese ground station at Kashima, 50 miles from Tokyo, for re-transmission to a specially modified antenna at Pt. Mugu, Calif.

ComSat Corp. is coordinating the project, according to the simultaneous release by the firm and the White House, "as a special experimental endeavor on a non-profit basis. It is doing so pursuant to a request by the Dept. of State that it would be in the national interest that this project be undertaken."

Hughes Aircraft Co. has been awarded a contract to modify the Pt. Mugu antenna. The contract calls for a fee of $250,000 to be paid Hughes for successful modification with the fee diminishing if the station is not ready to operate on the opening day of the Olympics on October 10 or if the station fails to operate during the 14-day period of the games. Radiation, Inc., of Melbourne, Fla., will assist Hughes in the modification. The antenna was turned over, free of charge, to ComSat Corp. by DOD.

In addition to the agreement with the Japanese government and the Japan Broadcasting Corp., arrangements have been made with the European Broadcasting Union in association with the Canadian Broadcasting Corp. for videotaping of the Olympics. This is expected to permit same-day coverage of the Olympics in Europe.

Total cost of the project is esti-

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket



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mated at approximately $350,000. Radio Corp. of America has agreed to provide $200,000 to the project cost on the basis of "its long standing interest in the development of communications satellites and participation in experimental work in this field."

The National Broadcasting Co., which has TV rights with the Japan Broadcasting Corp., has also agreed to provide for the furnishing without charge via *Syncom* the opening ceremonies of the games on October 10.

Meanwhile, an 18-nation plenipotentiary conference was concluded in Washington on "interim arrangements" for a global commercial communications satellite system. Although State Dept. and ComSat officials were cautious about the outcome, the nations could sign or initial agreements for the establishment of an international consortium to own and operate the global comsat system.

Two arrangements are under consideration by the participants. The first would be an inter-governmental pact on the organizational principals which would form the basis for the system, while the second would deal with the commercial, financial and technical operations. The latter would be signed by the communications entities of the participating nations. The two major issues remaining appear to be voting rights, particularly the constitution of a majority on a particular issue, and the length of time which the agreement would run.

The nations attending the Washington conference included in addition to the United States: Australia, Austria, Belgium, Canada, Denmark, the Federal Republic of Germany, France, Ireland, Italy, Japan, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. Any agreement reached will also be open to any member of the International Telecommunications Union. Nearly all the nations of the world, with the exception of Red China, belong to the 122-nation ITU.

Industry Briefings Set

Dept. of Defense has announced that a series of briefings on its long-range development needs will be held later this year. Under the sponsorship of the National Security Industrial Association, the briefings replace a similar set cancelled earlier this year.

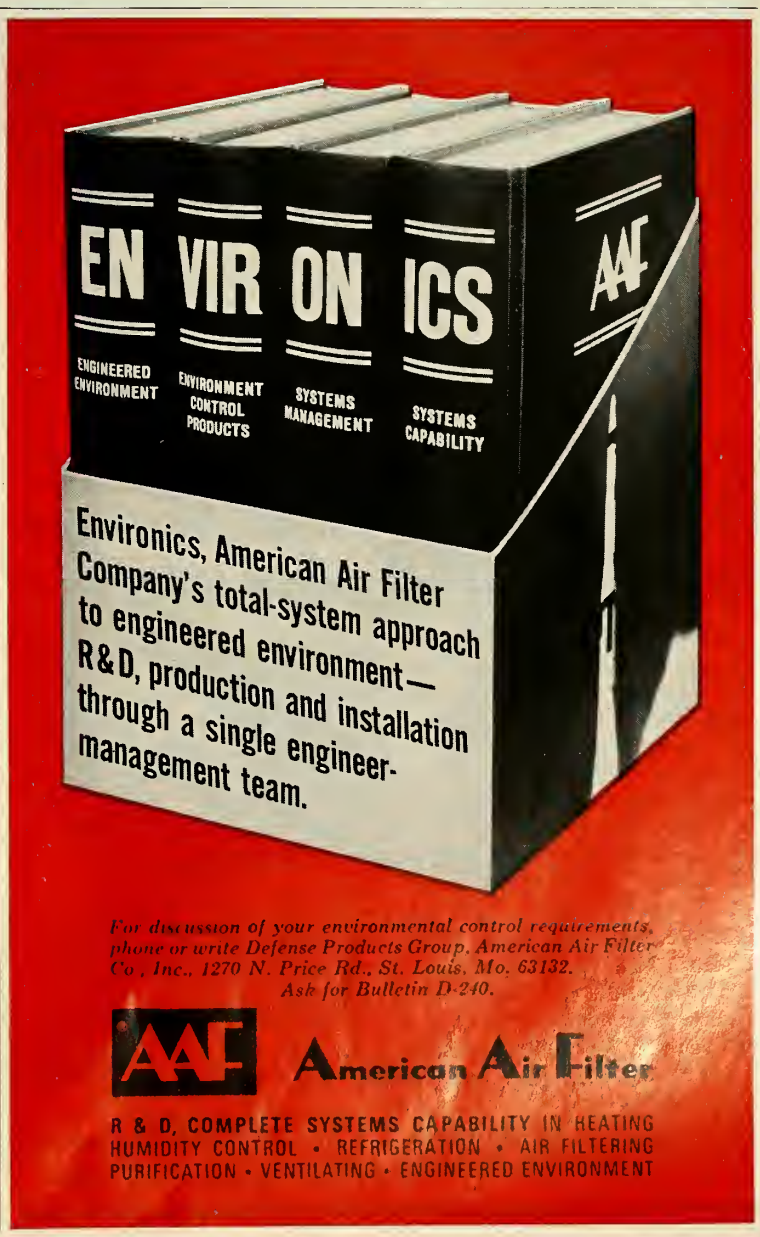
The first four briefings will be held in New York City, Sept. 17-18; Chicago, Sept. 29-30; Dallas, Oct. 13-14 and Los Angeles, Oct. 28-29. Eight additional regional briefings are planned for the spring of 1965.

Included in the briefings will be panel discussions and open forums covering: economic impact of DOD long-range planning on the defense industry; an intelligence briefing; DOD five-year force structure and financial program; advanced planning requirements; planning forecast for common use items; arms control and economic planning.

Also, economy in maintaining operational readiness; weapons acquisition and contracting trends; relationship of defense planning objectives to socio-economic programs; and international-military export sales potential.

DOD-industry relationships and the Defense Industry Advisory Council coordination of DOD participation in the program is to be handled by the Assistant Secretary of Defense (Public Affairs) Arthur Sylvester.

Industry's response to the earlier series of briefings announced last January was so great that they had to be cancelled due to the lack of facilities in Washington to handle all those who applied. The briefings, which covered specific requirements



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for military hardware in the future, were to have been classified, which further complicated the problem of accommodating the respondents.

The NSIA briefings will be unclassified. All planning for, and invitations to, the regional briefings will be handled by the NSIA Washington Headquarters, its city chapters and sponsoring industries. The only limitation on attendance will be the capacity of the auditorium in which the briefing will be held.

Second NDS Pair Fired

CAPE KENNEDY—Two *Nuclear Detection Satellites* (*NDS*) were successfully sent into 57,000-n.mi. orbits on July 17 by single *Atlas-Agena* combination space booster. It was the second launch in the series, which started with a successful shot last October.

In the latest launch, which occurred at 3:22 a.m., EST, July 17, all elements of the launch system performed as planned. The first-stage *Atlas D* gave a "plus" performance, reaching the required speed and position for *Agena* separation three seconds ahead of schedule.

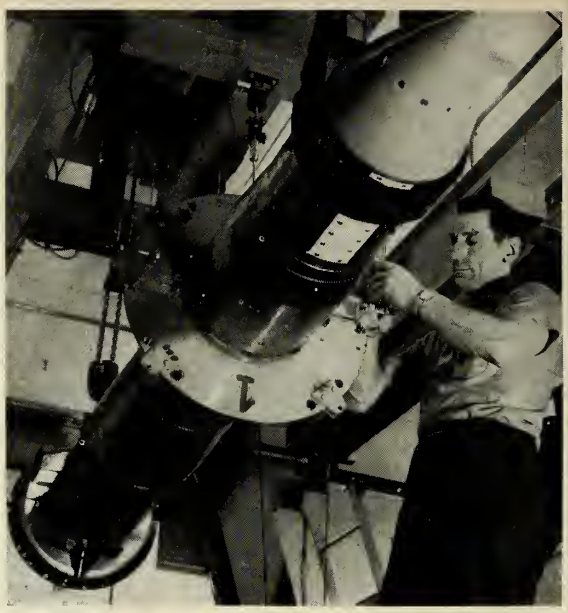
The satellites were started on the transfer ellipse at a 100-mi. altitude when they were separated from the *Agena* by a set of springs. Cold-gas jets oriented the spacecraft during the remainder of the flight.

The first satellite was injected into orbit by its solid rocket motor 19 hours after launch on command of the Air Force Satellite Control Center in Sunnyvale, Calif. The second *NDS* launched made one more highly elliptical swing past the Earth before reaching the 57,000-mi. apogee and orbital injection 59 hours, 11 minutes after launch at 2:33 p.m., EST, July 19.

Observation of the twin satellites reveals they are in an orbit inclined 37 degrees to the equator and they are 130 degrees apart. This separation will permit constant monitoring of the sunny and shadowy sides of the Earth to permit detection and reports of the presence of natural or artificial radiation.

The program to create a system of radiation detection satellites is directed by the Dept. of Defense Advanced Research Projects Agency and is managed by the Air Force Systems Command.

Subroc Warhead Checked

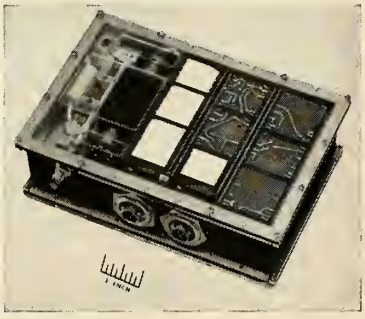


CENTER OF GRAVITY and "moment of inertia" on Subroc antisubmarine missile's warhead are pinpointed with this precise testing apparatus at the Goodyear Aerospace Corp. plant, Akron, Ohio. Company is prime contractor for the Navy weapon, which is nearing operational status.

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This 2-watt transmitter uses a triode-cavity power oscillator to achieve higher overall efficiency than is possible with all-solid-state transmitters. Frequency stability is achieved by an AFC servo loop referenced to a crystal oscillator. Tuning range is 2.2-2.3 Gc. Total volume is 50 cubic inches. Modulation linearity (maximum deviation from best straight line) is ±0.5% from ±10 Kc to ±300 Kc, and ±2.5% from ±10 Kc to ±1.5 Mc. Amplitude modulation is less than 5%. Susceptibility requirements of MIL-I-26600 are met. The solid state power supply operates from 28±4 Vdc with over 80% efficiency.



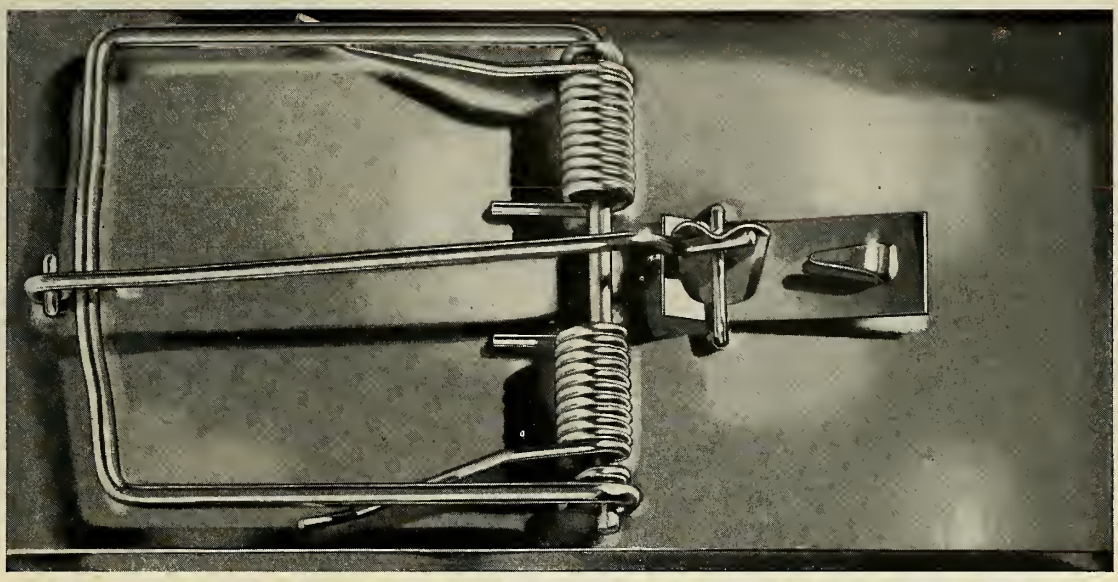
For complete information on this transmitter, contact Eitel-McCullough, Incorporated, San Carlos, California. In Europe contact Eitel-McCullough, S. A., Geneva, Switzerland.

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Correction

MISSILES AND ROCKETS (July 20, p. 14) erroneously referred to the *Delta* rocket stage that accidentally ignited at Cape Kennedy last April as an X-248 ABL. While Hercules Powder Co.'s Allegany Ballistics Laboratory designed the X-248 and produced them initially, the one involved in the Cape mishap was built by the Naval Propellant Plant, Indian Head, Md.



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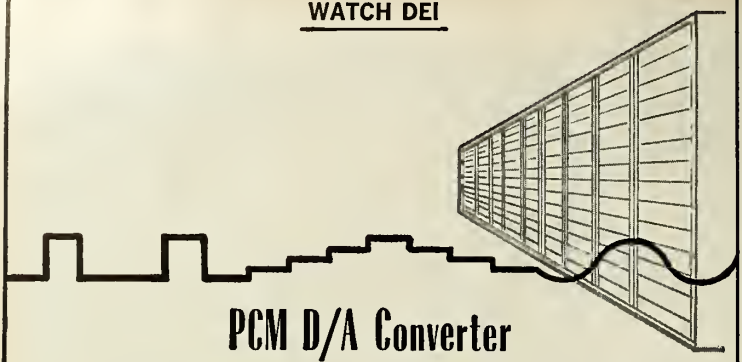
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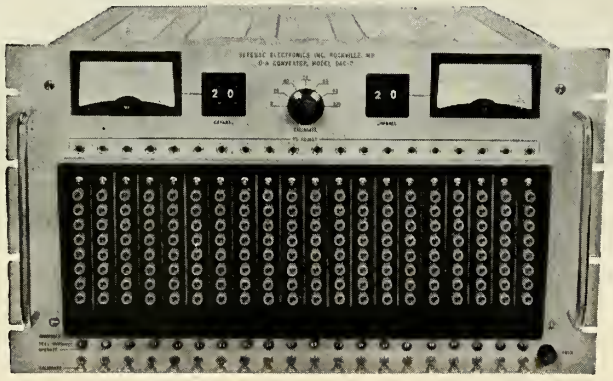
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Gen. Power Retiring

Strategic Air Command chief Gen. Thomas S. Power will retire Nov. 30, according to a White House announcement.

Power, a 36-year Air Force veteran, succeeded Gen. Curtis E. LeMay as SAC commander in 1957, when LeMay became Air Force Vice Chief of Staff.

NASA Invites Experiments

NASA has issued an invitation for the scientific community to participate in manned and unmanned space flights during the last half of the decade.

In a 75-page brochure listing detailed descriptions and time tables covering a wide range of space flight research opportunities, the Office of Space Science and Applications solicited scientific participation from domestic and foreign scientists in universities, industries and government installations.

"Purpose of announcing these opportunities in advance," according to Dr. Homer E. Newell, NASA Associate Administrator for SS&A, "is to obtain the broadest and best possible selection of in-flight scientific investigations."

Apollo, *Gemini* and *X-15* are listed as having available space for experimentation while *Tiros*, *Nimbus*, *Orbiting Astronomical Observatory*, *Orbiting Geophysical Observatory*, *Orbiting Solar Observatory*, five types of sounding rockets, and balloon flights are listed in the unmanned portion. Advanced Earth-orbit manned missions and advanced manned lunar missions are also listed for possible experimentation.

Deadlines for proposals range from September 1, 1964, to June 30, 1967, with the first spacecraft flights scheduled for 1966. Sounding rockets, balloons and the *X-15* have no proposal deadlines since these are continuously processed. Opportunities for experimentation aboard other unmanned lunar and planetary flights will be defined in separate announcements to be published semi-annually, NASA said.

Hypersonic Facility Planned

A hypersonic shock tunnel—simulating altitudes from 100,000-250,000 ft. and speeds of Mach 10 (7,620 mph)—will be built by Avco Corporation's Research and Advanced Development Div., Wilmington, Mass., for the Air Force's Aero Propulsion Laboratory, Wright-Patterson AFB. The facility is expected to cost $774,-

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000 and is scheduled for completion in August, 1965.

Test section of the 168-ft. tunnel will measure 36 ft. with an inside diameter of 10 ft. It will be used to evaluate experimental components of advanced air-breathing propulsion systems and to determine the properties of different gases as affected by pressure waves.

The Aero Propulsion Laboratory is part of the Research and Technology Div. of the Air Force Systems Command.

Shots of the Week

NASA on July 20 launched a pair of electric rocket engines into a suborbital arc from Wallops Island, Va., (see p. 18). One of the devices, an electron-bombardment engine developed by NASA's Lewis Research Center, worked "extremely well," but the Hughes Aircraft Co.-built contact-ionization engine, although it did ignite, failed to produce any thrust. Shots were the first in the space agency's Space Electric Rocket Test (SERT) program. The engines were boosted by a *Scout* vehicle.

• A NASA-launched *Nike-Apache* carried 84 lbs. of instruments 85 mi. into the sky above Cape Kennedy on July 16 to test the effects of the ionosphere on radio frequencies below 5 mc.

• On July 17, the Air Force launched the second pair of *Nuclear Detection Satellites* (formerly called *Vela Hotel* and *Vela High Altitude*) for the Dept. of Defense's Advanced Research Projects Agency (ARPA) (see p. 22). The shot, carried aloft by an *Atlas-Agena,* took place from Cape Kennedy. A third satellite, a 4.5-lb. "pygmy" package, was also on board the rocket. Its purpose is to study electrons in the Van Allen radiation belt.

• The Air Force successfully launched and recovered an *ASSET* materials testing vehicle from Cape Kennedy July 22.

The shot was the first total success in three firings of the craft, designed to gather data on winged, maneuverable, re-entry vehicles. The first shot (M/R, Sept. 23, 1963) sank before it could be recovered from the Atlantic Ocean; the second was destroyed when the second stage of the boosting *Thor-Delta* rocket misfired (M/R, March 30, p. 16).

The shot impacted near Antigua some 50-60 mi. short of the intended impact point. An Air Force pararescue team attached flotation gear to the craft to keep it afloat until it could be picked up by the U.S.S. Coastal Crusader, one of the Atlantic Missile Range ships. After pickup, the vehicle was to be flown at once to McDonnell Aircraft Corp. in St. Louis for study.

• West German army personnel successfully fired *Pershing* tactical missiles July 17 and again on the 22nd from the White Sands Missile Range, N.M. The Germans have recently completed *Pershing* training under the supervision of the U.S. First Field Artillery Brigade at Fort Sill, Okla.

ACDA Contracts Let

A study to establish an efficient inspection system for any arms control agreement that may be reached is to be conducted by Sylvania Electric Products under a $235,000 research grant from the U.S. Arms Control and Disarmament Agency.

Aim of the study, which is to be completed in June, 1965, is to develop an inspection system that will give a high level of assurance that no country exceeds the level of tactical forces and armaments that it had agreed to maintain.



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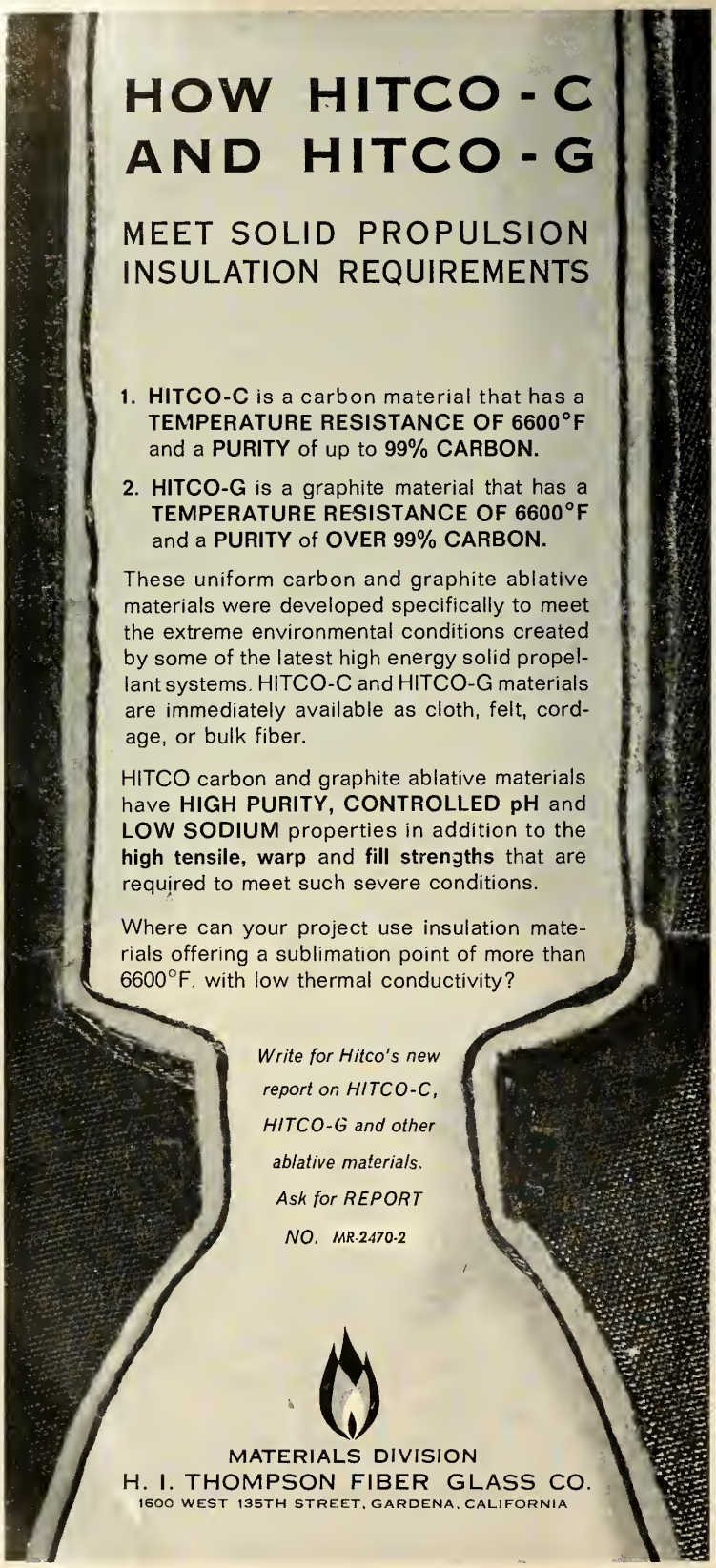
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Such a system might include resident inspectors at military installations where major forces are maintained or mobile ground teams able to move around on a country-wide basis. Techniques to protect national security interests of the signatories from the inspectors are also to be studied.

A second contract for $4,065 was awarded to the University of Michigan for a survey-type study of national and regional models of economic activity to determine the economic impact of arms control and disarmament.

Control Data Corp. received $75,000 for services providing personnel and facilities to process data for use in evaluating the effect of arms control and disarmament concepts on military capability.

Recreation Costs Probed

Lack of uniform interpretation of Armed Services Procurement Regulations (ASPR) governing contractors' expenses for employee "recreation and welfare" was immediately apparent in the first week of hearings by the House Armed Services Committee investigating subcommittee.

The Congressional unit, headed by Rep. Porter Hardy, Jr. (D-Va.), is delving into the expenditures of 28 major defense contractors at 36 plant locations. The General Accounting Office has questioned whether they should be allowed as chargeable to the government.

These expenses included free lunches in executive dining rooms, a crab feast, a trip to Disneyland for employees of one company and their families, gifts and picnics. These expenses, according to GAO, totaled $5.9 million. While $3.5 million, or 59%, had been financed primarily by commissions from vending machines and the remaining $2.4 million by company funds, over 75% of the latter has been or will be passed on to the government, GAO Comptroller General Joseph Campbell told the committee.

Campbell said there was little uniformity in the contractors' management and control of recreation and morale activities and expenditures. Nine out of the 36 plants surveyed provided recreation funds from income from the vending machines installed in the plant. At the others, however, the contractors provided financial support of which "a substantial portion of this cost was then prorated to government contracts." Further, GAO charged, most contractors donated the vending-ma-

chine funds to employee organizations, some of which accumulated cash and other assets in excess of $1 million.

"We noted that many contractors incurred sizable losses in food service operations—an employee activity comparable to vending-machine operations—and charged a substantial portion of these losses to the government. However, funds from vending-machine income were more than sufficient to offset the losses in food operations had they been used for such purpose instead of being donated to employee organizations," Campbell said.

Campbell told the committee that all these expenditures must be reviewed by agency auditors, and each individual contracting officer must decide whether or not they are allowable. Campbell cited "significant variations" in these interpretations and applications.

Such variations were evident in testimony before the committee. Harold D. Parsons and C. E. Deardorff, resident auditor and negotiator, respectively, for the Air Force at North American Aviation, testified that the Air Force allowed NAA to write off one-half of costs of an executive dining room at several locations. Executives eating at these dining rooms, the witnesses testified, were not charged anything for their meals, although cost of the food and service, excluding depreciation of the building and equipment, totaled $3 per meal.

Rep. Otis G. Pike (D-N.Y.), strongly questioned the propriety of such action, pointing out that it would appear that such costs are "unallowable" under ASPR regulations. It was also pointed out that the company had accrued hundreds of thousands of dollars in an employment aid fund, from vending machine profits. This, the Congressmen noted, would have been enough to cover the losses of the dining rooms.

Air Force auditors at Hughes Aircraft Co. also testified that the company took quite a loss in the executive dining rooms, although the diners are charged from 75¢ to $1.50 for their meals. It was brought out that these meals, again excluding building and equipment costs, actually cost from $4.10 to $5.10. Half the difference between what the executives pay and actual cost is absorbed by the government, witnesses testified.

Air Force contract officers and auditors for Martin-Denver were called upon to explain a 1962 crab feast held for executives and supervisory personnel. The crab feast itself cost about $4,410, the witnesses

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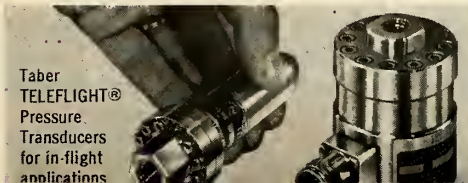


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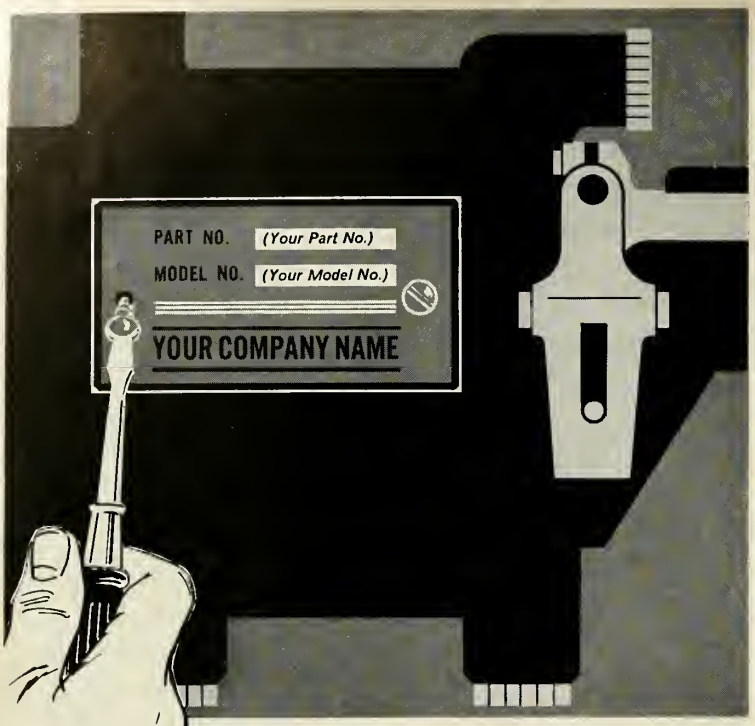
For detailed information, write: Aerospace Electronics Division, Taber Instrument Corp., Section 217, 107 Goundry St., N. Tonawanda, N. Y.



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testified, but $1,769 of a $6,318 plane trip was also attributable, since it covered transportation of the crabs from Baltimore to Denver. While Klement Anderson, principal administrative contract officer, said he interpreted ASPR to allow such an activity under "recreational activities," Pike said he felt that the same ASPR would prohibit such activity since it disallowed "meals."

McDonnell Aircraft Corp. was praised by the General Accounting Office for its use of vending-machine funds. Of $269,000 taken in, GAO said, $143,000 was used to cover employee activities including losses in cafeteria operations. The excess $126,000, Campbell told the committee, was applied to company overhead, "and as a result, prices under government contracts will be reduced."

Hardy in opening the session indicated that the General Accounting Office investigation was taken at the subcommittee request and any action will probably be in rewriting the ASPR's. No industry witnesses are expected to be called.

DOD Issues Cost Directive

A Cost and Economic Information System will be established on a department-wide basis as a result of Defense Department Directive 7041.1, issued July 7 by Deputy Secretary of Defense Cyrus Vance.

Purpose of the new system is to provide to all elements of DOD "comparable, reliable and timely cost and economic data on weapons systems, major items of equipment and Defense contractor employment. . . ."

Objectives of the information system are to:

—Improve cost estimating, cost and price analysis and progress reporting.

—Enhance the effectiveness of planning, programming, budgeting, contract negotiating, and program or project management.

—Provide data necessary for analysis of economic impact by geographic area and industry.

Cost data encompassing the full acquisition cycle of a weapons system as well as subsystems and major components will be collected and maintained along with plant and geographic employment data on defense contractors.

The Assistant Secretary of Defense (Comptroller) will have overall surveillance of the program and will head a Cost and Economic Information System Steering Group. Members of the steering group—

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Director of Defense Research and Engineering, Asst. Secretary of Defense (Installations and Logistics), representatives of the military departments, and other DOD groups—will develop the procedures and instructions for operating the information system.

The directive calls for a schedule and plan for implementation of the cost system within 30 days to be submitted to the Comptroller. The plan is to include establishment of cost analysis organizations, selection and schedule of weapon systems to be used in the initial implementation and list and schedule of remaining weapons systems or major items of equipment proposed for coverage.

House Votes Technology Panel

The House of Representatives has passed and sent to the Senate a bill providing for a National Commission on Technology, Automation and Economic Progress.

The Commission, which if approved would consist of fourteen members appointed by the President from outside the government, is to make a report in January, 1966, on these points:

—Past effects, and current and prospective role of technological change.

—Impact of technological and economic change in production and employment—with a ten-year projection on effect in specific industries, occupations and geographic areas.

—Unmet needs to which new technology could be directed.

—Specific legislative steps to aid this development.

The bill also calls for a committee consisting of the heads of the Departments of Agriculture; Labor; Commerce; Defense; Health, Education and Welfare; the National Aeronautics and Space Administration; the Atomic Energy Commission; the Council of Economic Advisers; and the Director of the Office of Science and Technology.

The move parallels action in the Senate to create such a commission, with particular emphasis on the effect on the defense industry. Some governmental opposition has been voiced, however.

Wakelin Joins Ryan

Dr. James H. Wakelin, Jr., recently retired Assistant Secretary of the Navy for Research and Development, has been named by board chairman Claude Ryan to head the technical advisory board of Ryan Aeronautical Co.

Wakelin will work in a consulting capacity with Dr. Frank W. Fink, Ryan vice president for research and engineering, and with technical staff members concerned with V/STOL aircraft, target drone systems, electronic navigation and space programs.

An industrial and research physicist, Wakelin had headed the Navy's R&D efforts since 1959.

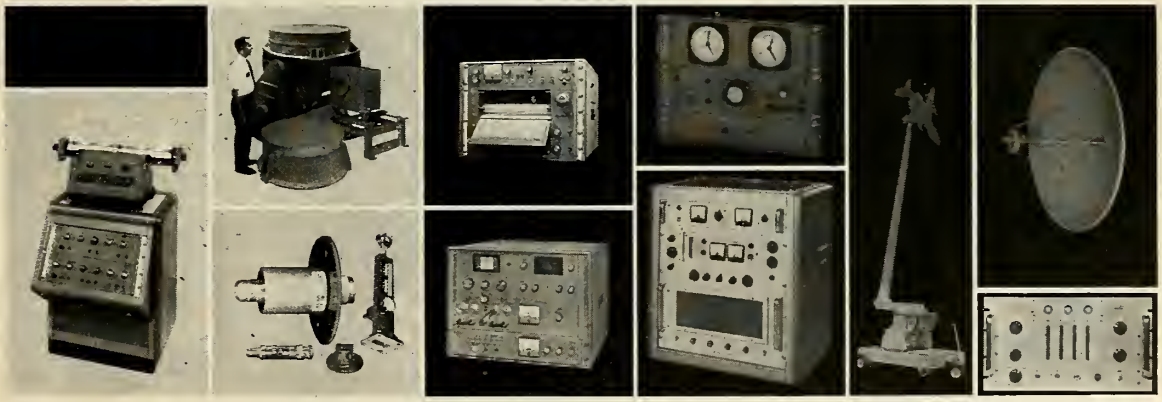
NASA, ESRO in Pact

NASA and the European Space Research Organization (ESRO) have signed an agreement calling for the launch of two Earth-orbiting satellites.

Under the terms of the agreement, ESRO will build the satellites, which will be launched by the space agency using a *Scout* booster from the Western Test Range in 1967.

The agreement—the first between NASA and the European group—brings to 13 the number of international satellites launched or planned by the space agency.

ESRO, which came into formal existence in March, 1964, is a nine-



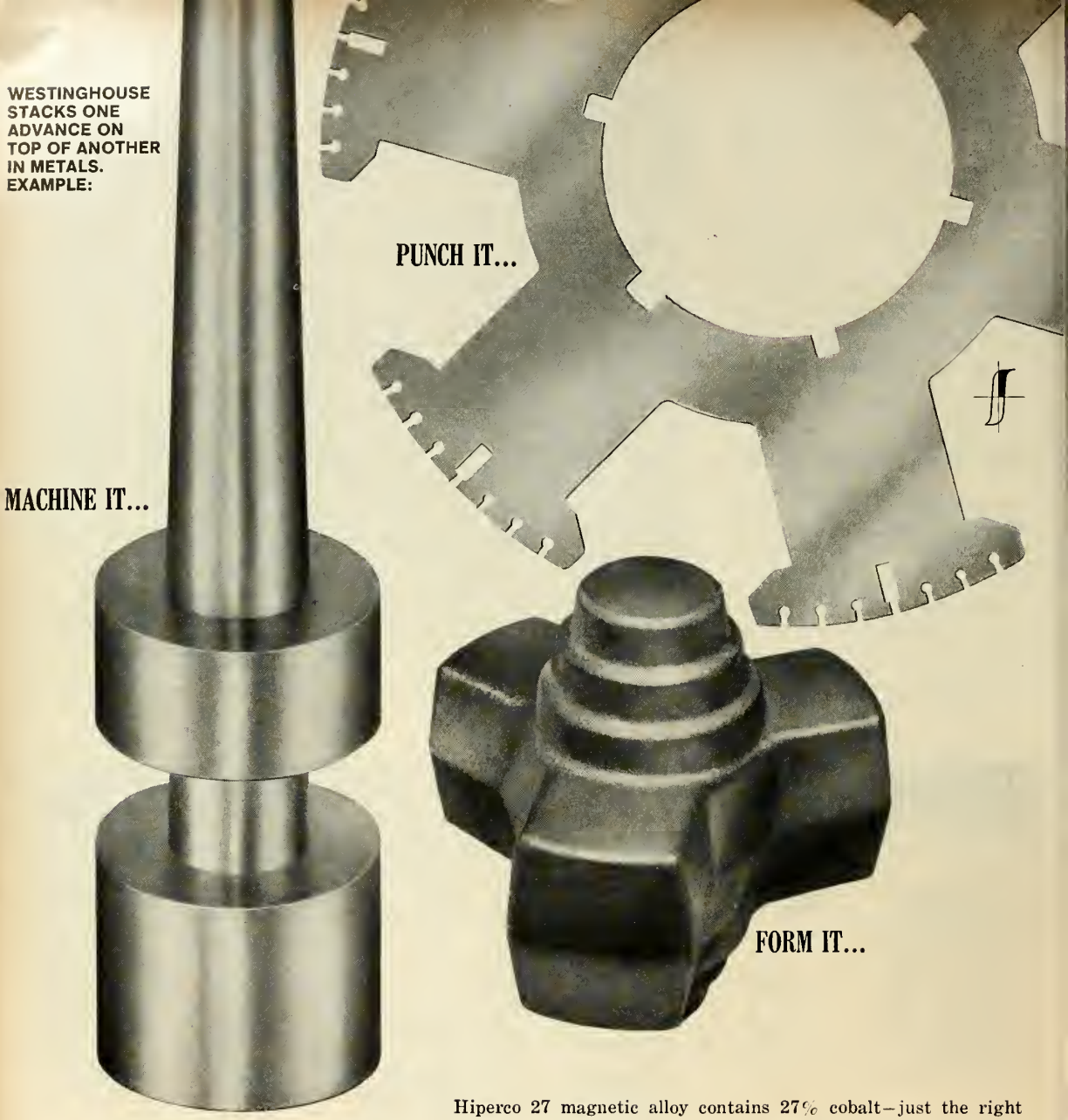
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nation West European group formed to conduct scientific space research utilizing the capabilities of its member countries.

Its members include Belgium, Denmark, France, Federal Republic of Germany, The Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. Italy is expected to join when the Italian government ratifies the ESRO Convention. In addition, Austria has observer status.

The ESRO space program calls for sounding rocket and satellite experimentation and the establishment of several research centers and a launching site in its member countries.

Under the Memorandum of Understanding, the first satellite, to be known as *ESRO I*, is to contain eight experiments to study high-altitude particles (especially in auroral phenomena) and their effects on the polar ionosphere. *ESRO II* is to measure solar and cosmic radiation and will also contain eight experiments.

Under the agreement, ESRO will provide the experiment instrumentation; design, construct and test the spacecraft; provide ground checkout and launch support equipment; track and acquire data from the spacecraft within the capability of its projected network; and reduce and analyze all data.

NASA will train ESRO personnel as is mutually determined, provide the *Scout* launching vehicles, and conduct the launching operations. NASA will also provide necessary supplemental tracking and data acquisition support.

Neutron Star Search Continuing

A program of four sounding rocket launches a year over the next several years is planned by the Naval Research Laboratory in a continuing search for neutron stars.

A July 7 launch from White Sands Missile Range was described as a complete success by Dr. Herbert Friedman, chief scientist of NRL's E. O. Hulbert Center for Space Research.

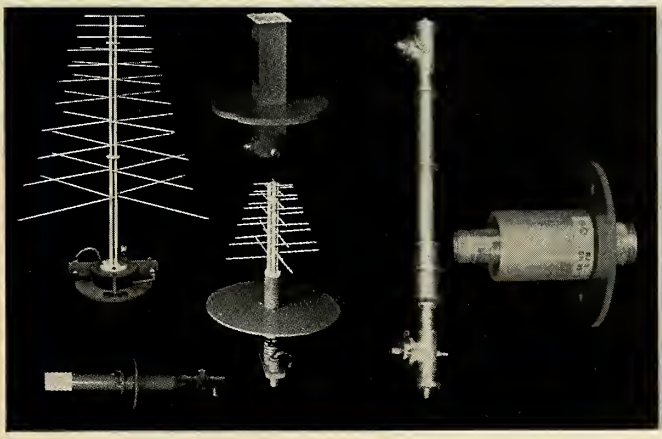
Purpose of the launch was to determine whether a point source of X-rays existed in the Crab Nebula. Using the Moon to occult the nebula, the *Aerobee 150* rocket's instrumentation was designed to detect any sudden drop in X-ray emission from the nebula.

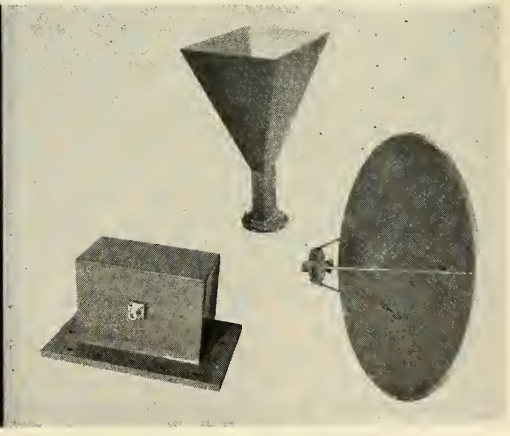
Such a drop would indicate that there was a point source of X-rays in the nebula. No such drop occurred and Friedman concluded that there is definitely no neutron star in that area of the sky.

The *Aerobee* reached an altitude of 144 miles and provided data for 5 minutes. Precise launch of the vehicle was required since there was only a 15-second window available if the occultation by the Moon of the nebula was to be used to advantage. Such an occultation is relatively rare —occurring only once every nine years.

Next area of investigation for the NRL scientists will be the region of Scorpius in which a much stronger source of X-rays was detected last year. Advanced instrumentation will be used rather than depending on the infrequent occultation of part of the sky by the Moon for future shots. A mechanical scanner and greater pointing accuracy will be included in future instrumentation.

So far, eight sources of X-rays have been located (including the one in the Scorpius region). However, with what Friedman termed normal improvements in instrumentation, he expects to locate 25-30 such sources as well as to pinpoint already identified sources against the star background.





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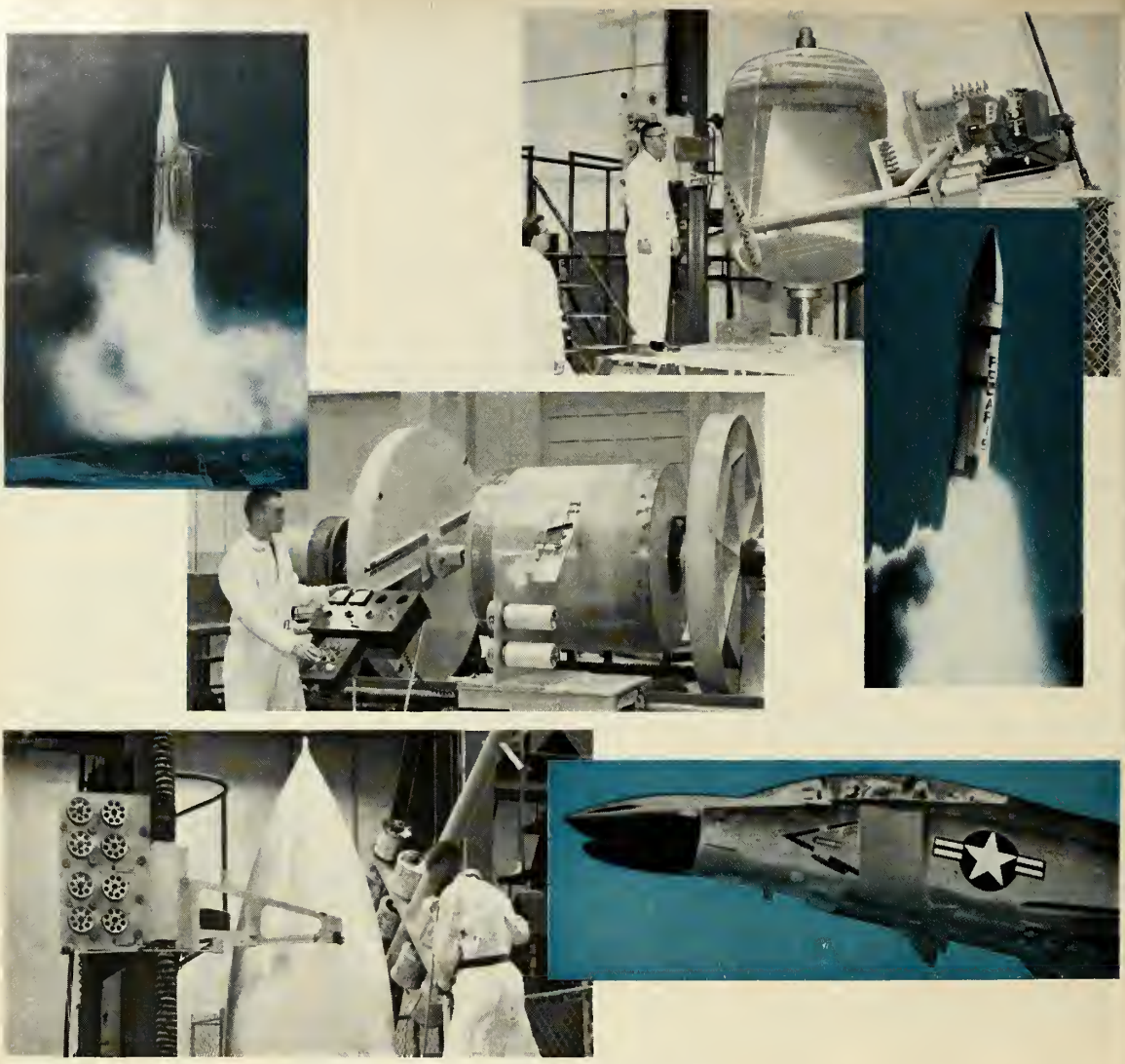
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Missile programs such as MINUTEMAN and POLARIS have utilized the advantage of filament wound motor cases for minimum weight. Brunswick's new Lincoln, Nebraska, facility has available the latest equipment for producing and testing rocket motor cases, nozzles, pressure vessels, containers, under-water vehicles and other high-strength lightweight structures. Lincoln's versatile equipment requires minimum additional tooling, assures complete reproducibility and reliability for high volume mass production components.

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Cape TV Awards Let

Two Milwaukee firms have won a joint contract to install 10 camera pads, two television sites and a weather station to support the *Titan III* and *Saturn V* projects at Merritt Island and Cape Kennedy.

The contract was awarded by the Corps of Engineers to the Akwa Construction Co., Inc., and Downey Heating Co., Inc., and calls for payment of $604,547 for the work, which must be completed by next March.

The camera pads will be located on the north end of Merritt Island and be used to record launches on film. The television sites at the Cape will contain equipment that will monitor launches and provide information for range safety officers. The weather station, which will have a 54-foot tower and an 8 x 8-ft. equipment building, will be constructed on Merritt Island.

Planes May Become Spotters

A top U.S. aircraft designer envisages follow-on aircraft to the B-52 and B-58 bombers as highly sophisticated spotters for missile systems rather than as weapons delivery systems themselves.

C. L. (Kelly) Johnson of Lockheed Aircraft Corp. told reporters during a Washington press conference he felt it would be cheaper in the long run to have such spotter aircraft signal back for additional missile firings in case of a miss rather than have the aircraft deliver its own weapons.

Kelly expressed his opinions prior to accepting the National Aviation Club's achievement award for development of the YF-12A (A-11) aircraft.

Zero-G Facility Used By Martin

Drop tests with a 1,300-lb. aluminum capsule falling into a bin of wheat are being employed by the Martin Co. at its Denver division to obtain data on zero- or near-zero-gravity phenomena.

Results of the tests will be used primarily to help propulsion-system designers anticipate the various conditions experienced by future space vehicles.

In the unusual test facility, the 10-ft. x 3-ft.-dia. capsule, containing a smaller cylinder, is pumped down to a near vacuum. The capsule is hoisted to the top of an 80-ft. tower, held by an electromagnet, and then dropped into a bin containing 300 bushels of wheat to minimize impact. A maximum of 25 g's is experienced by the capsule during deceleration.

During the roughly 2-second free fall, the cylinder, which carries the experiment or payload, falls at a faster rate than the capsule and, in effect, nullifies gravity since it is not subjected to air resistance.

Also, using a new patented device, details of which have not been revealed by Martin, other experiments can be conducted in fractional gravity. The mechanical, spring-loaded device, according to Martin, permits the adjustment of gravity during free fall down to 0.001 normal gravity on Earth.

Monex Studies Funded By AF

Rocket Research Corp. will investigate and evaluate Monex, a high-energy monopropellant under a $65,-964 Air Force contract, the Seattle firm announced last week.

A principal objective of the program, RRC disclosed, is to develop a high-energy propellant formulation that will be safe to handle. The propellant is intended for use as primary propulsion in military rocket systems.



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The work is sponsored by the Rocket Propulsion Laboratory at Edwards AFB, Calif. The lab is a facility of the Research and Technology Div., USAF Systems Command.

The need for a satisfactory monopropellant, or single-fluid rocket system, has long been recognized by U.S. propulsion firms, but earlier monopropellants, RRC disclosed, have been unsuitable for primary propulsion—either total energy output has been too low to be effective, or such systems have tended to explode during handling.

Rocket Research Corp. experiments, during the past three years, resulted in the development of a stable compound. Monex, the firm claims, can be handled safely without fear of accidental detonation.

New Alloy Ready for Tests

New beryllium-aluminum alloys, called Lockalloy, are now commercially available, the Beryllium Corp. announced last week. Berylco has begun production of the first of a series of Lockalloy sheet at its Reading plant (M/R, July 20, p. 9), and the material will be available for test and evaluation by industry.

Lockheed Missiles and Space Co. announced last September the successful development and testing of the new material. It reportedly combines the high modulus and low density of beryllium with the high formability and desirable shop characteristics of aluminum. The nominal chemical composition of the material is 62% beryllium and 38% aluminum by weight, Berylco said.

Applications for the alloys include missiles, satellite launch vehicles, and both military and commercial supersonic aircraft. Other potential applications, the company suggested, include nuclear fuel canning, gyroscope cages, aircraft brakes, computer memory drums and discs, and radiator sections for space vehicles.

Developed specifically for aerospace structural applications, the new alloys are expected to give designers a means for decreasing weight significantly and improving elevated-temperature performance in lightweight structures. Developmental studies originated at Lockheed's Materials Sciences Laboratory. Dr. Raymond W. Fenn, Jr., staff scientist for LMSC, predicted weight savings of up to 40% by substituting Lockalloy for HM21A-T8 and HK-31A-H24 magnesium alloys, now being used by the missile/space industry.

ENGINEERS & SCIENTISTS

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INFRARED Add new high-resolution spectrometers for launch and re-entry coverage ... new IR systems to extend mid-range coverage.

RANGE SAFETY Study and develop areas of explosive hazard assessment, including instrumentation to cover chemical fuel explosions and nuclear fuel excursions.

INSTRUMENTATION & VEHICLE CONTROL Add a 64-man central control at the Cape to direct operation of the entire range ... new real-time dual-system computer facility (including 2 CDC 3600's) for failure-proof high-speed data handling.

CORRELATION Reduce time correlation uncertainty across the range to less than 10 microseconds ... standardize the timing signal format on the Eastern Test Range to be compatible with other national ranges.

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METEOROLOGY Improve cloud height and growth indication instrumentation ... develop a system to measure atmospheric electrical potential and cloud movement.

SHIP & AIRCRAFT INSTRUMENTATION Improve the instrumentation to meet more stringent telemetry, navigation, tracking, communications, and data handling requirements ... phase into operation new and/or modified tracking ships and aircraft.

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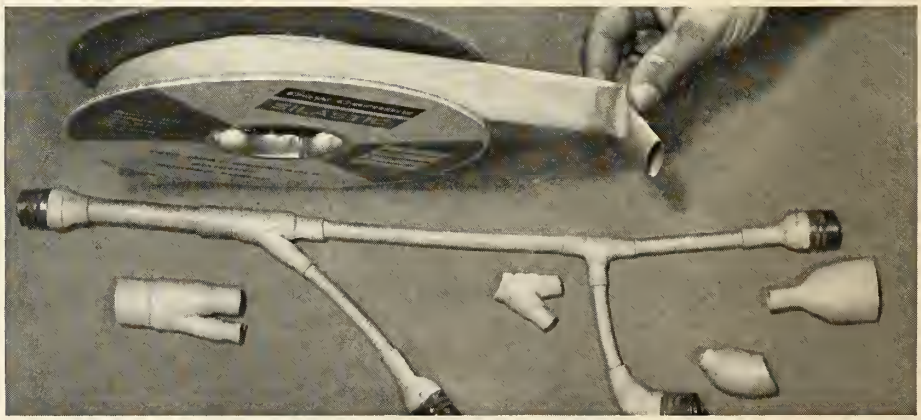
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News Briefs



A new heat-shrinkable silicone rubber, supplied in the form of finished parts by Dow Corning, shrinks to one-half its original diameter when heated briefly at 300F. Silastic® 1410 heat-shrinkable rubber provides tight, form-fitting protection for wire harnesses, cable splices, miliconductor cables, hydraulic and mechanical couplings, or acts as cable blast shields in rocket launching applications. After shrinking, this material retains its flexibility from —100 to 500 F. Available in a range of stock tubing sizes or as custom made parts of varying shapes.

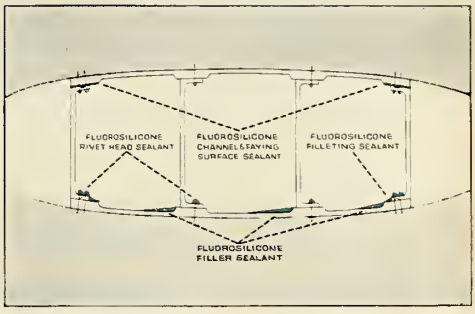
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New fluorosilicone rubber sealants seal integral fuel tanks on F-111

A new family of one-part fluorosilicone rubber sealants, developed by Dow Corning for the aerospace industry is meeting the needs for fuel resistant seals in high performance aircraft. Because of their flexibility and strength while immersed in jet fuel at temperatures from −70 to 500 F, four of these sealants were selected by General Dynamics for use in sealing critical areas of the integral fuel tanks in the F-111 Air Force/Navy tactical fighter.

A special fluorosilicone sealant which air cures to a resilient rubber was developed for use in filleting, another for rivet head and fastener coverings. Low spots that would form natural sumps are filled with a low density fluorosilicone sealant. Finally a *non-curing* sealant was designed for channel and faying surfaces.

The three sealants which cure to a strong rubber retain peel and bond strength after prolonged immersion in jet fuels or when subjected to splash and fume exposure of rocket fuels such as nitrogen tetroxide or hydrazine. All have excellent resistance to ozone, oxygen, many chemicals, weather, aging and thermal cycling. These fuel tank sealants are simply examples of Dow Corning's ability to engineer products for specific aerospace applications.



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New non-corrosive sealants, for aerospace applications, are now available from Dow Corning. These one-component sealants cure at room temperature to tough silicone rubber without liberating acetic acid; therefore are not noxious when used in confined areas. Common aerospace *structural* metals and materials show no corrosive reaction to these new sealants. They can be used for bonding, sealing, encapsulating, and coating surfaces which require heat, age and weather resistance. These sealants are ideal for construction of missiles and rockets as well as for on-site maintenance.

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For further information about materials described here . . . or our capability to provide you with tailor-made materials designed specifically to meet your requirements, write Dept. K607, or call Aerospace Materials Dept., Dow Corning, Midland, Michigan.

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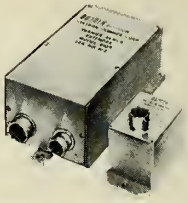
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NOT PICTURED BUT SIMILAR IN APPEARANCE TO THE MODEL 4310 ARE:

Model 5310 Flexure Accelerometer, specially designed for high g applications. A flexure supported lightweight mechanism eliminates null uncertainty normally experienced with jewel bearing type accelerometers.

Model 4810 Guidance Accelerometer with high performance torque coil that improves hysteresis, non-repeatability and zero output by a factor of 10 to 1.

Model 4211 Low Cost Servo Accelerometer — A pivot and jewel pendulous accelerometer with all the features of a true servo accelerometer for a price below $400.

Model 5410 Non-pendulous Accelerometer — A high compliance, pure translational accelerometer utilizing a non-pendulous flexure suspended seismic mechanism. Features high output, high resolution and high accuracy in environments of high acceleration, shock and vibration.
Key specifications: non-linearity <0.05%; hysteresis <0.02%; resolution infinite; range ±0.5 g to ±30 g; shock, 50 g operating, 200 g survival. Physical configuration, round case.

Model PHU Miniature Free Gyro—This unit combines a low cost miniature design with a very flexible choice of made-to-order modifications. It can be adapted to a variety of applications where space limitations are critical and performance is a must. Options include manual or electrical cage and uncage, remote or integral power supply, and single or dual pickoffs. Measures only 2" in dia. by 2" long; weight 9 oz.

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Key Specifications: ranges, ±0.05 g to ±35 g; input power, +28 vdc ±2 vdc; output, two 0-5 channels; weight 2.5 lbs.

OTHER SYSTEMS—

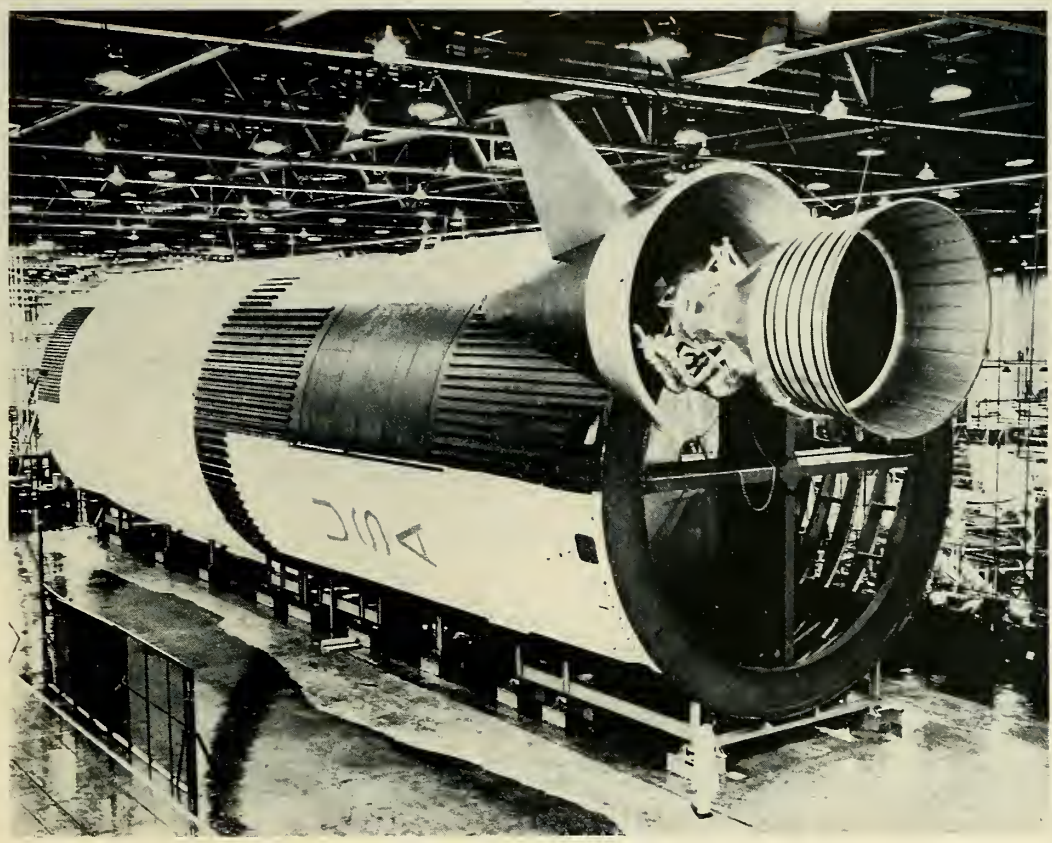
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FABRICATION of Saturn V first stage mockup continues at Marshall Space Flight Center. Stage will be used to check out handling and test facilities.

missiles and rockets eighth annual

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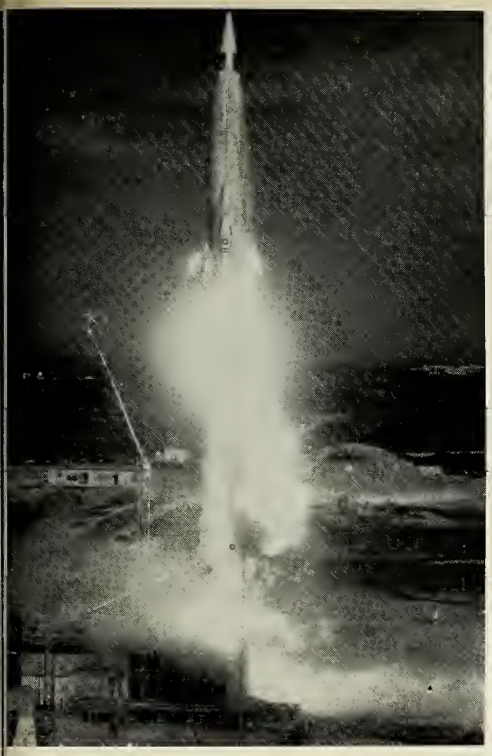
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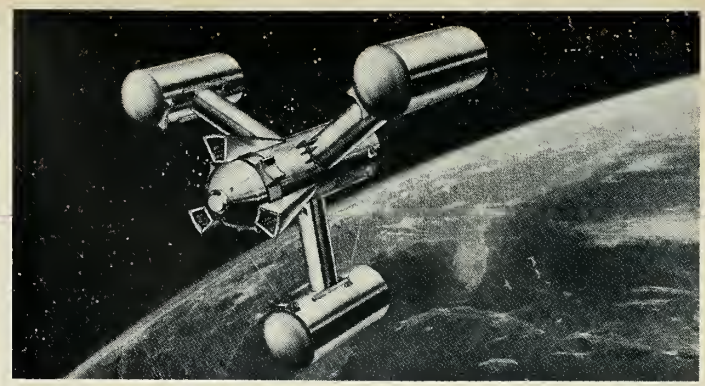
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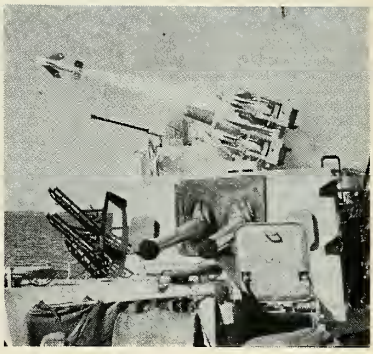
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UNITED STATES

SPACECRAFT

Apollo Command & Service Module (NASA)

TYPE: Three-man spacecraft

MISSION: Manned lunar landing; ferry vehicle for manned space stotion

STATUS: R&D

PRIME CONTRACTOR: North American. Subs: stabilization and control, Honeywell, parachute recovery, Northrop; power conversion equipment, Westinghouse

GUIDANCE: Astro-inertial with rodio-inertial bockup; systems management, MIT Instrumentation Laboratory; prime contractor, AC Spork Plug; associate contractors, Raytheon, Kollsman, Sperry Gyroscope

TELECOMMUNICATIONS: Collins Rodio

CONFIGURATION: 3-module spocecroft; weight, 85,000 lbs.; diameter, 13 ft.; command module, 10,000 lbs., 12 ft. high; service module, 46,000 lbs., 23 ft. high, (see also Lunar Excursion Module entry)

ENVIRONMENTAL SYSTEM: AiResearch

HEAT SHIELD: Avco

AUXILIARY POWER: Fuel cell, Pratt & Whitney

PROPULSION: Escape motor, Lockheed, solid; reaction control, liquid, Marquardt; service module propulsion, Aerojet-General, liquid

BOOSTER: Saturn I, Soturn IB and Saturn V

REMARKS: First lunar landing planned for 1969, but slippage into 1970's is probable; Earth orbit tests of boilerplate Apollo started in 1964; first three-module flight slated for 1966, with first manned flight scheduled for 1967 with Saturn IB; lunar orbitol flight may be made in 1968

Extended Apollo (NASA)

TYPE: Manned spacecraft

MISSION: Three men for 90 days in space-station flights or as supply vehicle for space stations or lunar base development

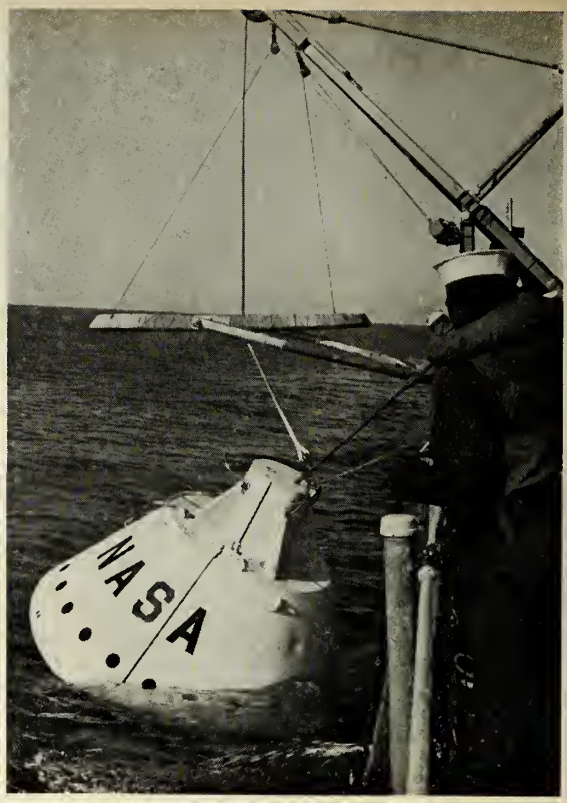
CONFIGURATION: Basic Apollo spocecraft would be used; one concept would simply add more expendoble supplies to extend capability; another would reploce Lunar Excursion Module (LEM) with a mission module to lengthen its orbital capability

STATUS: Study

CONTRACTOR: Study contract, North American Space and Information Systems Div.; other study contracts awarded for spacecroft systems

BOOSTER: Saturn V

REMARKS: Studies expected to continue in FY '65; hardware funding expected in FY '66 or '67



APOLLO COMMAND MODULE

ASSET (Air Force)

TYPE: Non-orbitol research vehicle

MISSION: To test various materials combinations for applicability to lifting body re-entry

STATUS: Flight test

PRIME CONTRACTOR: McDonnell

CONFIGURATION: Aerothermodynamic/Elastic Structural Systems Environmental Tests vehicle; deltoshaped: two versions planned, weighing 1,100 lbs. (4 vehicles) and 1,200 lbs. (2); length, 68.7 in., span 58.9 in.

GUIDANCE CONTRACTOR: Honeywell

BOOSTER: Atlas

REMARKS: First shot in September, 1963, successful in that 130 channels of data were telemetered back, but failure in that vehicle was not recovered; expanded program to investigote lifting body re-entry aver broader range of flight regimes and materials is being formulated to take up gap created by X-20 cancellation

(Project) Fire (NASA)

TYPE: Re-entry probe

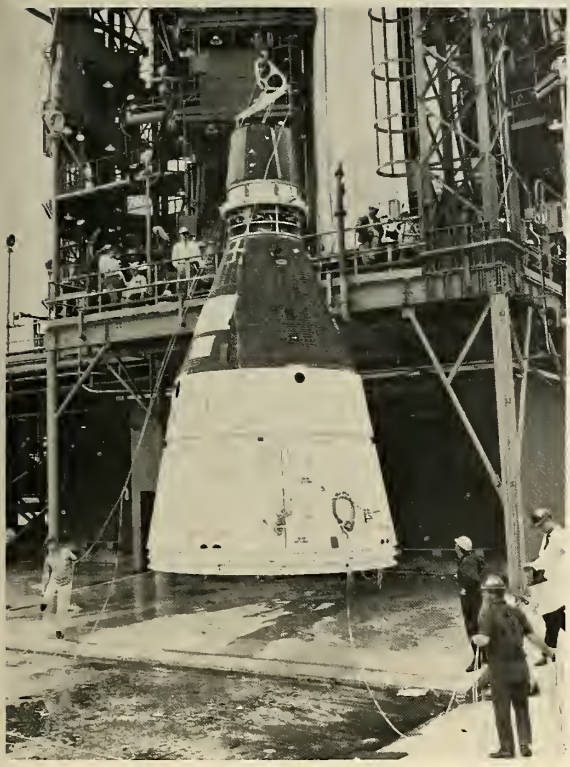
MISSION: To measure environmental heating conditions at lunar-return speeds (25,000 mph)

STATUS: R&D

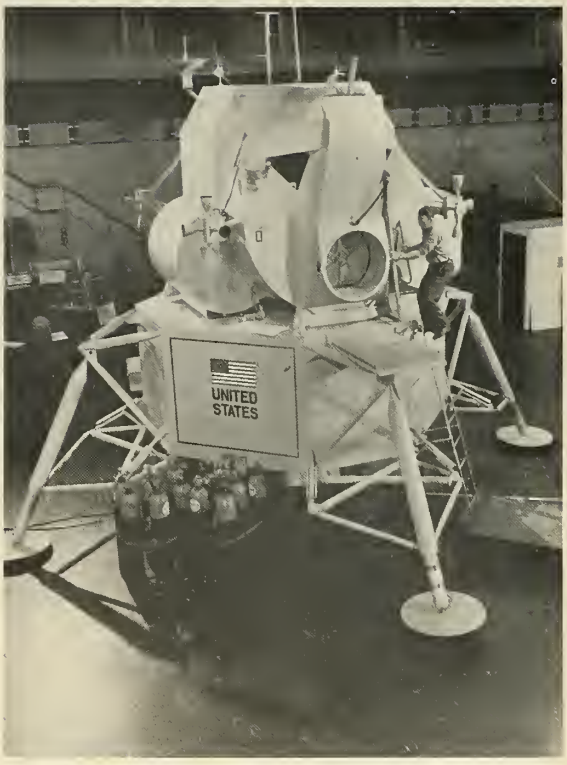
LAUNCH VEHICLE: Atlas D, plus Antares II A-5 (re-entry booster)

PRIME CONTRACTORS: Re-entry package, Republic; velocity package, Ling-Temco-Vought; launch vehicle and systems integration, General Dynamics/Astronautics

REMARKS: Re-entry package instrumented to define total heating and radiative components of the re-entry environments for lunar-return speeds; first flight April, 1964, successful; second flight scheduled for mid-1965



GEMINI



LUNAR EXCURSION MODULE

Gemini (NASA)

TYPE: Two-mon spocecroft

MISSION: Carry two men on arbitol flights lasting up to two weeks; test orbital rendezvous feosibility

STATUS: R&D

PRIME CONTRACTOR: McDonnell

HEIGHT: 7 ft.

WEIGHT: Appraximately 7,000 lbs.

GUIDANCE: Guidance integration, IBM; rendezvous rodor, Westinghouse; spacecraft, all-inertiol, Haneywell

PROPULSION: Spacecroft, Rocketdyne

ENVIRONMENT SYSTEM: AiReseorch

FUEL CELL: GE

POWER: Botteries and fuel cell

BOOSTER: Titan II; Agena will be used during rendezvaus missions; Atlas will launch Agena into arbit

REMARKS: 12 flights scheduled for 1964-66—first flight, unmonned, April 8, 1964, was successful; secand unmanned bollistic shat scheduled for third quarter; first manned 3-orbit mission eorly in 1965; first orbitol rendezvous will be attempted on GT-6

Lunar Excursion Module (LEM) (NASA)

TYPE: Two-man spacecraft serving as third module af the Apolla spacecraft

MISSION: Land two men an Moon, then rendezvaus with orbiting Apalla

STATUS: R&D

PRIME CONTRACTOR: Grummon

WEIGHT: 25,000 lbs.

PROPULSION: Lunar descent, Rocketdyne ond TRW STL; ascent engine, Bell Aerasystems; reaction cantral, Marquardt; environmental cantrol, Hamiltan Stondord; guidance, MIT; rador and communications equipment, RCA; TMC, telemetry, Radiation, Inc.; fuel cell, Prott & Whitney; external visual display, Farrand Opticol

POWER UNITS: Fuel cells

BOOSTER: Saturn IB for Eorth-orbitol missians; Saturn V far lunar-landing flights

REMARKS: Eleven flight vehicle ond nine engineering madels ordered; first three-module Apollo flight scheduled for 1966, with first lunar landing planned far 1969, but slippage into 1970's prabable

LORL (Large Orbiting Research Laboratory) (NASA)

TYPE: Large monned space station

MISSION: Carry 24 or more men an Earth-orbiting missions lasting one to three yeors; could also be used os an ossembly point for manned plonetary flights

CONFIGURATION: Three radial module with central hub that can be rototed to simulote zero g; diameter, 150 ft., weight, 247,000 lbs., volume, 67,000 cu. ft.

STATUS: Study

CONTRACTOR: Spacecroft study contract, Lackheed; many ather studies awarded

BOOSTER: Saturn V

REMARKS: Hardwore development aff for severol years

Hypersonic Research Vehicle (Air Force, NASA)

TYPE: Manned spacecraft capable af Earth-orbit-and-return

STATUS: Study contracts; campanent development

PRIME CONTRACTOR: Na majar contractors announced

PERFORMANCE: To be capable af accelerating ta arbital speeds fram o harizantal or vertical launch

PROPULSION SYSTEM: Turbafan, Mach 0.3; romjet, Mach 3-8 or 10 (oxygen liquified during this cycle); Mach 8-10, rocket (LH_2-LOX)

REMARKS: Funded by bath AF and NASA as a jaint research project, system holds most interest far AF as an operationol vehicle; NASA funding is far $2.5 million for FY '65

Lunar Logistics System (NASA)

TYPE: Unmanned spacecraft

MISSION: Land supplies on the Moon in support of Project Apollo or as o logistics carrier in the construction of a lunar base

STATUS: Study

DESCRIPTION: Two possible configurations are under study: modified Lunar Excursion Module (LEM) of the Apollo spacecraft would provide a 7,000-lb. payload capacity; specially developed lunar logistics system weighing 90,000 lbs. would land a 25,000-lb. payload on the Moon

PRIME CONTRACTOR: None; study contracts by Grumman, TRW STL and Northrop completed; next step may be program definition

BOOSTER: Advanced Saturn

REMARKS: Program decision delayed until Fiscal 1966 budget discussions; expected that $30 to $40 million may be available for program in that year; LLV will serve as the basic supply vehicle for such lunar base concepts as LESA (Lunar Exploration System far Apollo) and ALSS (Apollo Logistic Supply System); LESA would maintain three men on the Moon for 90 days; ALSS would keep two men on the Moon for 14 days

Mariner (NASA)

TYPE: Unmonned interplonetary spacecraft

MISSION: Scientific exploration flights to the vicinity of Mors and Venus; advanced version also under development

STATUS: R&D

PRIME CONTRACTOR: JPL; study contracts on 1969 mission with Lockheed and Avco

CONFIGURATION: 1964 Mariner will weigh 570 lbs.; loter Mariners will be considerably heavier

INSTRUMENTATION: Instruments will change from mission to mission; first Venus spacecraft, Mariner II, had radiometers, magnetometer, radiation counters ond cosmic dust detector; first Mors spacecraft, Mariner C, will have television, mognetometer, radiation counters and cosmic dust detector

BOOSTER: Atlas-Ageno for 1964 mission; Atlas-Centour for later missions

REMARKS: Successful Venus fly-by accomplished December, 1962; Mars fly-by scheduled for late 1964; first Centaur-launched spacecroft being considered for late 1966; another flight to Mars planned for 1969 may include a capsule londer

Lunar Orbiter Photo Craft (NASA)

TYPE: Unmanned scientific satellite

MISSION: 800-lb. spacecraft to take pictures of the Moon's surface as well as radioactive and geodetic meosurements

STATUS: R&D

CONTRACTOR: Prime, Boeing; power ond communicotions, RCA; cameras, Eastman Kodak

BOOSTER: Atlos-Agena

REMARKS: Ten flights scheduled with first in 1966

Mercury (NASA)

TYPE: First U.S. manned spocecraft

MISSION: Carried one man on Earth-orbitol flights

STATUS: Completed

PRIME CONTRACTOR: McDonnell

WEIGHT: 4,000 lbs. plus (including escape tower); 2,000 plus on impact

GUIDANCE: Honeywell, stabilization system; Bell Aerospace, system manager

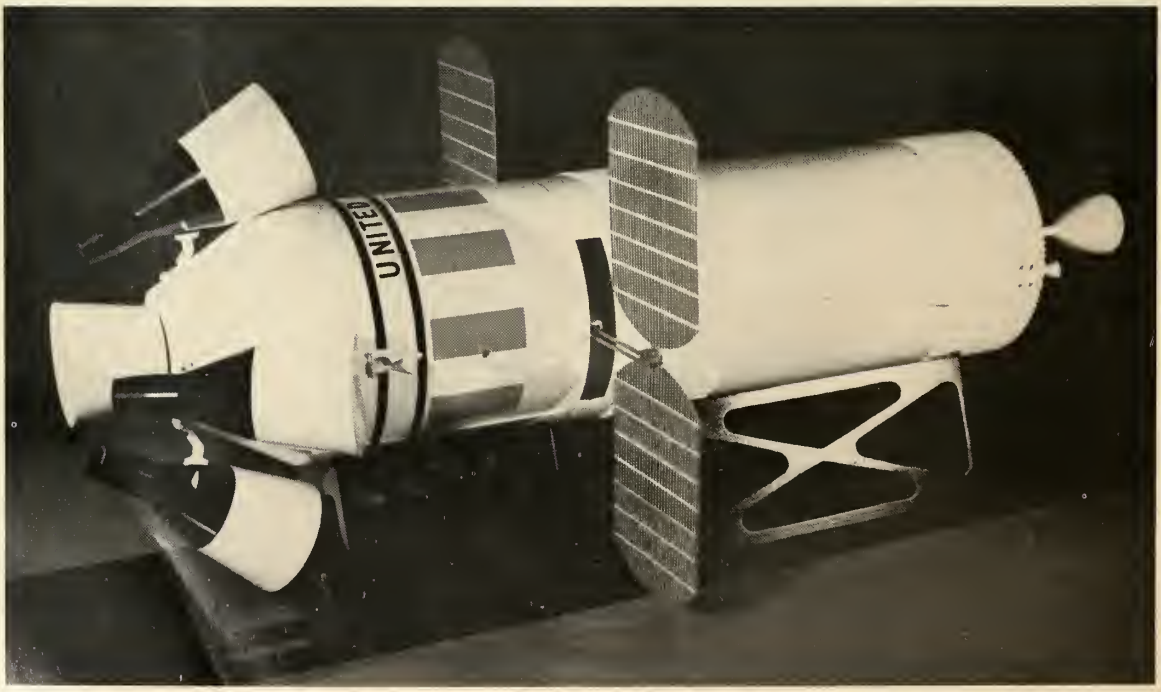
AUXILIARY POWER: Batteries

PROPULSION SYSTEM: Escape rockets, solid; retro rockets, solid; control system, liquid

BOOSTER: Atlas D

REMARKS: First U.S. manned suborbital flight May 5, 1961, by Lt. Cmdr. Alan Shepard, USN; second manned suborbital flight July 21, 1961, by Moj. Virgil Grissom, USAF; first U.S. manned orbitol flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC, 3 orbits; second manned orbitol flight May 24, 1962, by Lt. Cmdr. Scott Corpenter, USN, 3 orbits; third manned orbital flight Oct. 3, 1962, by Cmdr. Walter Schirra, USN, 6¾ orbits; fourth manned orbitol flight May 15-16, 1963, by Moj. Gordon Cooper, USAF, 21¾ orbits; last flight set U.S. record of 34 hrs., 20 min. for manned spoceflight

MORL



MOL (Manned Orbiting Laboratory) (Air Force)

TYPE: Twa-man spacecraft

STATUS: Pre-program definition

MISSION: To estoblish military usefulness of mon in spoce

PRIME CONTRACTOR: Nane; study cantracts awarded ta Douglos, GE and Martin on Orbiting Space Station (OSS) are expected to provide inputs far MOL definition

CONFIGURATION: Gemini-B capsule otop 10-ft.-dio., 20-ft.-long lab conister "obout the size af a small house troiler"; lob weight estimoted at B,000 lbs. with tatal MOL weight of 18-20,000 lbs.; lob will be divided inta three sections: a crew comportment, work oreo (both pressurized) ond unpressurized orea for experiments and equipment; capability af maintaining crew far 30 doys in o shirt-sleeve environment

ORBIT: Appraximately 300-mi. orbit planned with launch from Eostern Test Range

BOOSTER: Titan IIIC

REMARKS: After industry competitian late this year, AF hopes to award development contract by Moy, 1965; first unmonned Gemini flight early 1966; unmanned MOL launch lote 1967; monned MOL launch first holf 196B; rendezvous copobility moy be introduced later; DOD officials stress that it is experimental, not operotionol system

MORL (Manned Orbiting Research Laboratory) (NASA)

TYPE: Manned space stotion

MISSION: Corry faur to six men on space station flights lasting up ta one year

CONFIGURATION: Cylindrical structure with 5,000-cu.-ft. volume; weight, 30,000 lbs.

STATUS: Study

CONTRACTOR: Study contract, Douglos; many other system studies being made

BOOSTER: Saturn IB

REMARKS: Development hinges on go-ohead for Nationol Orbiting Space Stotion Program; decision still one to faur yeors off

Pioneer (NASA)

TYPE: Unmanned interplonetary probe

MISSION: 140-lb. spin-stabilized spocecroft to abtain informotion obout interplanetory enviranment and send dota back to Eorth ot distances up ta 60 million miles

STATUS: R&D

PRIME CONTRACTOR: TRW STL

BOOSTER: Thrust-Augmented Delta

REMARKS: Seven flights in program, first flight in 1965

Ranger (NASA)

TYPE: Lunar hard-landing spocecroft

MISSION: 300-lb. instrumented capsule rough-lands on Moon; before impact, TV cameros take pictures of lunar surface

STATUS: R&D

PRIME CONTRACTOR: JPL, prime; Aeronutronic, capsule; Hercules, retrorockets; Northrop, support contractor

INSTRUMENTATION: TV cameras, seismometer

POWER UNITS: Solor cells

BOOSTER: Atlas-Agena

REMARKS: First six flights were unsuccessful; first two failed to lounch from orbit; Ranger III lounched Jan. 26, 1962, failed to impact on the Moon, went into solar orbit; Ranger IV impacted on the back side of the Moon Apr. 26, 1962, but transmitted no doto; Ranger V missed Moon and is now in solor orbit; Ranger VI impacted Moon Feb. 2, 1964, in desired oreo, but TV comeros foiled to operate; next launch, third quorter, 1964; program reduced from 14 to 9 spocecroft

Project Scanner (NASA)

TYPE: Unmonned scientific prabe

MISSION: To measure the natural rodiation grodients that define Eorth's horizon os seen from space vehicles in severol bonds of the electromagnetic spectrum, and the oltitude relotionship of these grodients to the solid Eorth horizon

STATUS: R&D

CONTRACTORS: Spacecraft fabricotion and integrotion, Honeywell; stor-mopper telescope, Baird-Atamic; duol rodiometers, Santa Barbaro Reseorch Center

REMARKS: Each spacecraft will cantoin duol rodiometers giving high resalutian data in at least two spectrol regions; the spocecraft will olso incorporote o precision orientotion determinotion system (stor-mopper telescape) so thot the spectrol doto will be Eorth-referenced; flights ta begin in lote 1965

SERT I (NASA)

TYPE: Ballistic trojectory test vehicle

MISSION: 375-lb. spacecraft to study ion engine beom neutrolizotian problem

STATUS: R&D

PRIME CONTRACTOR: RCA

REMARKS: First flight expected in mid-1964; one ather flight test plonned; SERT I will test two engines: one, developed by the Lewis Research Center, with o thrust of 0.00637 lbs. and specific impulse of 4,900 sec. is an electron bombardment engine using mercury as o propellont; other, developed by Hughes, is a contact ianizotion engine using cesium os a propellont—weight, 0.001 lbs. with a specific impulse of B,050 sec.

RANGER



SERT I



Surveyor (NASA)

TYPE: Lunar soft-landing spacecraft
MISSION: soft-land 2,150-lb. spacecroft on the Moon
STATUS: Development
PRIME CONTRACTOR: Hughes
INSTRUMENTATION: 100-300 lbs. of scientific instruments including stereo panoromic TV, X-roy diffractometer, surfoce sompler, touchdown dynomics, micrometeorite experiment
BOOSTER: Atlas-Centaur
REMARKS: First Maon flights scheduled in early 1965; seven soft landers planned; SNAP-11A moy be used on later flights

Voyager (NASA)

TYPE: Unmanned planetory spacecroft
MISSION: Unmanned Mariner fallow-on to orbit Mars and Venus and to eject a capsule to the surface
STATUS: Study
PRIME CONTRACTOR: None; study contract with GE
INSTRUMENTATION: Not determined
BOOSTER: Not determined; probobly Saturn IB with third stoge
REMARKS: First flight possible in early 1970's; funding moy begin in FY '66 budget

X-15 (NASA, Air Force)

TYPE: Manned rocket oirplane
MISSION: To provide data on hypersanic flight and serve as research croft far experiments related to space and aeronauticol sciences
STATUS: R&D flight-testing
PRIME CONTRACTOR: North American
PERFORMANCE: Speed, 4,104 mph (mox.); altitude, 354,200 ft. (max.)
AIRFRAME: System contractor, North American; length 50.2 ft.; launch weight, 33,400 lbs.; landing weight, 14,500 lbs.; wingspan, 22.4 ft.
GUIDANCE: Inertial flight data system, Sperry Gyroscope; adaptive flight cantrol system, Honeywell
AUXILIARY POWER UNITS: System cantractor, GE
ENGINE: System contractor, Thiokol; propellant, liquid ammania; oxidizer, liquid oxygen
THRUST: 57,000 lbs. total from Thiokol Type YLR-99
REMARKS: Plane #3 set oltitude recard of 354,200 ft. Aug. 22, 1963; plane #1 set speed record for monner power flight of 4,104 mph on June 27, 1962; X-15-2 modified for M-8 flight by addition of externol tanks (launch weight increosed to 50,914 lbs.); will alsa be used as o test bed for ramjet engines with flights in 1968

Advanced Technological Satellite (NASA)

TYPE: Unmonned scientific satellite
MISSION: 650-lb. satellite to flight-test communicatian and meteoralagicol equipment at medium and synchanous orbit; it will serve as o test bed for a gravity gradient experiment
STATUS: R&D
PRIME CONTRACTOR: Hughes
BOOSTER: Atlas-Agena
REMARKS: Program calls for five sotellites with the first lounch scheduled for 1966; first two flights will be into medium orbit

Biosatellite (NASA)

TYPE: Unmanned scientific satellite
MISSION: Test effects of spaceflight on various plont and animal life farms, including primates, for periods up to 30 days
STATUS: R&D
PRIME CONTRACTOR: GE
BOOSTER: Thrust-Augmented Delta
REMARKS: Six 1,000-lb. satellites scheduled with first launch expected late in 1965; 14 experiments chasen for Biosotellite-A

X-15





Is it fish or foul play?

Sorting out real target information from the rest of its watery environment is one of the most complex problems of antisubmarine warfare.

This year ITT was named systems manager for the new Atlantic Undersea Test and Evaluation Center (AUTEC) that will be the principal U.S. Navy facility for checking out ASW weapons systems. AUTEC will be an "inner space" range, the first capable of precision tracking in an underwater atmosphere of great distance and depth.

Soon the whole range of ASW problems—detection, classification, pinpointing and destruction—will be examined in a controlled, yet authentic, marine environment.

AUTEC will be 100 miles long, 20 miles wide and 6,000 feet deep. ITT will lace this ocean area with hydrophones and other sensitive instruments, erect tracking gear to permit thorough underwater evaluation of such advanced ASW weapons as SUBROC and ASROC.

ASW is not new to ITT. World War II's HUFF-DUFF system that pinpointed U-boat radio transmissions, no matter how brief, was an ITT development.

In 1957, after solving the problem of high density storage of multichannel analog information, ITT developed equipment to record underwater acoustical environments. Now, ITT sonar simulators using tapes of actual conditions can train up to 10 sonarmen at once.

Currently, ITT is developing DINAH, an advanced underwater detection system based on electro-magnetic principles.

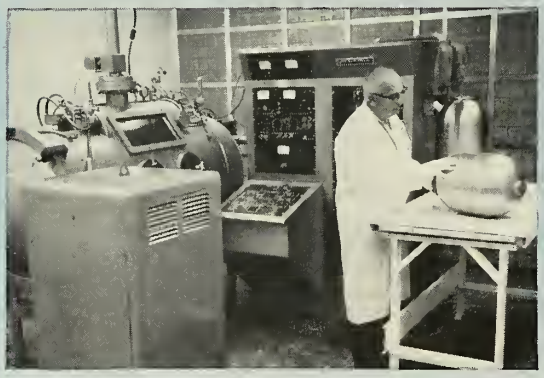
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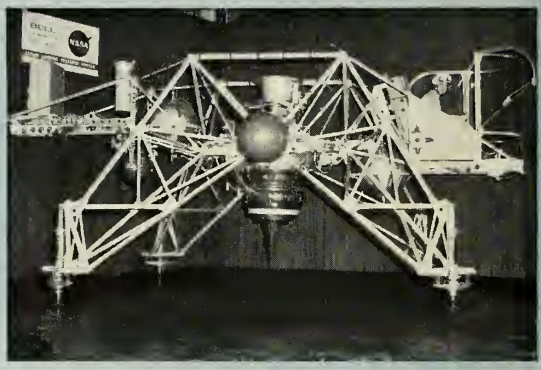
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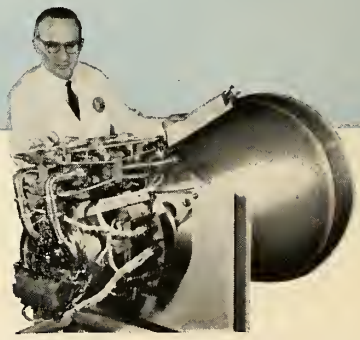
ROCKETRY



Extensive manufacturing capability at Bell supports its rocket propulsion programs with the exacting and precise fabrication of major components such as thrust chambers, valves, tanks, positive expulsion devices, gas generators and pumps. Bell is well-known for developing many advanced processes and materials and today is working with complete columbium thrust chambers as well as titanium and A-286 stainless steel tanks. Shown is a thin-walled, 0.015 inch thick, titanium tank following welding in one of Bell's vacuum welding chambers. Close bead tolerances are maintained by use of advanced fixturing and welding techniques. This forms a part of Bell's complete capability for design, fabrication and testing of rocket propulsion engines and tanks.



A Lunar Landing Research Vehicle, one of two recently delivered to NASA, will be used for free flight simulation of the moon landing operation. These LLRVs have the three-fold purpose of exploring problems associated with lunar landings, of providing data to aid in the design of the Lunar Excursion Module, and of training the Apollo astronauts. Twenty-two Bell rocket engines are used for stabilization and maneuvering of the vehicle.



The Lunar Excursion Module Ascent Engine represents one of the most difficult Apollo development items. Burning storeable hypergolic propellants, this ablative engine has a thrust of 3,500 pounds. Bell has had high altitude firings in the development of this LEM takeoff engine which will start our Apollo astronauts on their way back to earth.

USAF AEROSPACE 10 ANNIVERSARY

Bell Salutes
USAF Ballistic Missile
& Space Program



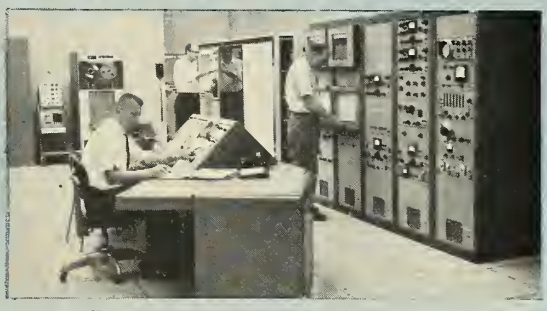
Bell is supplying both primary and secondary propulsion for the Gemini Target Vehicle. The designs are an advanced modular concept. The Gemini Agena engine provides multiple restarts in space and is a further development of the Agena engine which has a demonstrated reliability record of over 99% in more than 100 firings in space.



Bell's advanced reaction control thrust chamber efforts have been aimed at resolving major technological problems. Typical is the columbium radiation cooled 100 pound-thrust rocket engine shown being fired in one of Bell's high altitude facilities. The 100 pound size, exhibiting high durability and pulse operation, is applicable to many of today's space programs operating on storable bi-propellants.



Clean room facilities include Class 4 and are among the most completely equipped. View shows the secondary propulsion module of the Gemini target vehicle in a clean room. This module integrates in a single unit all propulsion system components including positive expulsion tankage, pressurization system, bi-propellant thrusters together with valves, regulators and other related equipment.

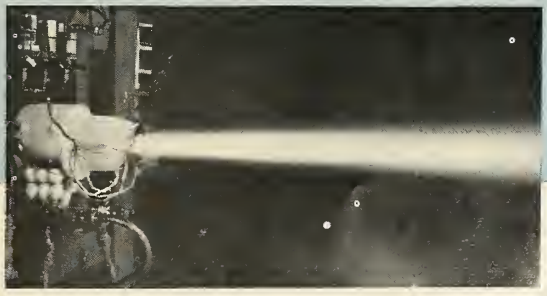


A Data Processing Center with a Beckman Model 210 Digital Acquisition unit and an IBM Digital Computer serve the Bell Rocket Test Facility. High frequency dynamic data are recorded on a Sangamo Model 4742 and analysis is performed on a Dynamic Wave Analysis System. Also available for design, engineering, value analysis and program management (PERT) is an IBM 7090.

The Program Manager, Technical Director and PERT Supervisor of the LEM ascent engine program team discuss a problem. Bell places major emphasis on program management and uses the latest management tools on a routine basis. This, plus highly qualified personnel and weekly program reviews with top management, optimizes performance for both long range and fast-moving short-schedule programs.



Typical of Bell's work in providing increased rocket engine capability is the successful firing (illustration) of a fluorine-oxidized ablative chamber for over 2 minutes duration. High energy rocket efforts have included work with fluorine, OF_2, pentaborane, CTF, methane and classified compounds. Bell continues to lead in fluorine rocket development and has recently tested a 40,000 pound thrust $F_2 - H_2$ rocket.



Bell has established a reputation for tackling difficult programs of an advanced nature and of successfully developing highly reliable high performance rocket propulsion systems. This includes rocket engines with thrusts ranging from ounces to 40,000 pounds and components such as propellant tanks, pressurization systems, positive expulsion devices, valves and controls. Bell has an outstanding record of leadership in rocket propulsion not only with today's propellants but also with advanced storable and cryogenic fuels and oxidizers. In addition, Bell is a pioneer in the technological development and application of many advanced materials and propulsion design concepts and avionics components such as accelerometers and digital velocity meters. Bell . . . setting a fast pace in space.

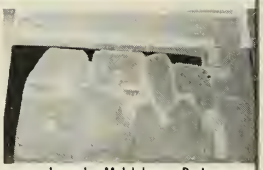
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We Take The MATERIALS and PROCESSES OF TOMORROW...



and Chem Blank ..... Irregular Molybdenum Parts



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Hot Rivet ..... Molybdenum Panels



Stretch Form ..... Columbium Structural Members



Slurry Coat ..... Columbium Panels



Grind ..... Zirconia Nose Caps



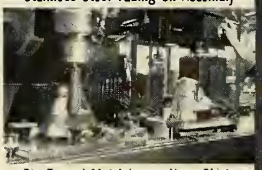
*Fusion Weld ..... Thin Sheet Titanium



*Induction Braze ..... Stainless Steel Tubing On Assembly



*Mold ..... Ablative Heat Shields



Mill ..... Die Forged Molybdenum Nose Skirts



Assemble ..... Man-Rated Spacecraft



Test ..... Full Scale Reentry Spacecraft



MERCURY



ASSET



GEMINI

AND FLY the SPACECRAFT OF TODAY

For the Aeronautical Systems Division of the Air Force Systems Command (ASSET), and for the Manned Spacecraft Center of the National Aeronautics and Space Administration (Mercury and Gemini)

*Patents Pending

MCDONNELL
ST. LOUIS

FIRST FREE MAN IN SPACE

Circle No. 1 on Subscriber Service Card

ComSat Corp. System

TYPE: Communications satellite

STATUS: Study

MISSION: Provide basis for operational commercial communications satellite system

PRIME CONTRACTOR: None selected yet; three six-month engineering design contracts let to AT&T/RCA, TRW STL/ITT and Hughes

CONFIGURATION: AT&T/RCA will study a random-orbit, medium-altitude system of 18 satellites with 530 high-quality voice channels; TRW STL/ITT will also study medium-altitude (6,000-n.mi.) system with emphasis on controlled-orbit 12-satellite system using gravity-gradient stabilization and 800-1,200 voice channel capacity; Hughes basically a study and preliminary design of next-generation synchronous satellites beyond Early Bird; system under study would have 600 duplex voice channels or two TV channels

BOOSTER: Delta or Thrust-Augmented Delta under consideration

REMARKS: If medium-altitude random system is selected, plans are to have first satellites in orbit by mid-1966, using multiple launch techniques; entire system in orbit within year from first launch; if synchronous, two satellites would be placed in position over the Atlantic by mid-1966, a third over Pacific or Indian Ocean the following year; DOD negotiating with ComSat for use of system on DOD's terms

Discoverer (Air Force)

DESIGNATION: Program 622A

MISSION: Military satellite testbed

STATUS: Operational

PRIME CONTRACTOR: Lockheed, overall; GE, re-entry vehicle; Bell Aerospace, propulsion

PERFORMANCE: Variable orbits, depending on mission; multi-restart engine gives considerable latitude

CONFIGURATION: Uses Agena-series satellites; initial configuration—length, 19.2 ft.; diameter, 5 ft.; weight, about 1,700 lbs.; all dimensions except diameter increase 1/3 to 1/2 depending on payload

BOOSTER: Thor or Atlas with Agena upper stage

RE-ENTRY VEHICLE: GE-designed, capsule type, 27-in. length, 33-in. diameter, weight about 300 lbs.

REMARKS: Data on program now classified; used for testing space effects on bioastronautic specimens, materials and equipment; indications are that cheaper methods are now being used to launch these payloads and the Discoverer program has been greatly reduced

Early Bird (HS-303) (ComSat Corp.)

TYPE: Communications satellite

MISSION: To obtain information for design of commercial system and provide experience in operations

STATUS: Development

CONFIGURATION: Modified Syncom designed to provide up to 240 two-way telephone channels between U.S. and Europe or simultaneous transmission of 22 or more telegraph messages

PRIME CONTRACTOR: Hughes

ORBIT: To be placed in 22,300-mi. stationary orbit over Atlantic

BOOSTER: Thrust-Augmented Delta

REMARKS: Contract calls for delivery of first satellite by April, 1965, and second later in the year; launch scheduled for mid-1965; NASA will provide launch services on reimbursable basis

Echo (NASA)

TYPE: Inflated balloon passive communications satellite

MISSION: Reflect radio signals off large (100 ft., Echo I; 135 ft., Echo II) inflatable spheres in circular orbits (890 mi., Echo I; 725 mi., Echo II)

STATUS: All launches complete

PRIME CONTRACTOR: NASA

FRAME: Mylar plastic and aluminum foil laminate, Echo II; aluminized mylar, Echo I

INSTRUMENTATION: Tracking beacons on sphere

POWER UNITS: Batteries and solar cells

BOOSTER: Thor, Thor-Delta and Thor-Agena

REMARKS: Echo I in orbit since Aug. 12, 1960; two ballistic shots were conducted from AMR—first Jan. 15, 1962 (sphere ruptured), second July 18, 1962 (sphere inflated safely but was underpressured); Echo II launched Jan. 25, 1964, from PMR in polar orbit, 642- to 816 mi.; no more launches

Explorers (NASA)

TYPE: Unmanned scientific satellites

MISSION: To explore the atmosphere, ionosphere, magnetosphere and near-Earth region of interplanetary space with satellites specifically designed for each special mission and to provide cooperative in-flight space research opportunities for the international scientific community; orbits vary widely

STATUS: Both R&D and study

PRIME CONTRACTOR: Changes from mission to mission

CONFIGURATION: Designs vary greatly in size and shape depending on mission requirements

INSTRUMENTATION: Instruments vary according to needs of particular mission

BOOSTER: Scout, Delta and Thor-Agena

REMARKS: 38 spacecraft have been authorized with 27 more planned; Explorer I launched Jan. 31, 1958, and latest, Explorer XIX, launched Dec. 19, 1963; Explorers have provided great quantities of scientific information on such phenomena as the Van Allen radiation region, the ionosphere, air density, meteoroids, magnetic fields, energetic particles, solar pressure and the effects of solar activity of the Earth environment; others will continue and complement these studies and explore new areas of interest

FR-1 (France/NASA)

TYPE: Unmanned scientific satellite

MISSION: 140-lb. satellite to measure electronic and magnetic components of ULF radio emissions from a near-polar orbit of 800 kilometers altitude

STATUS: R&D

CONTRACTOR: France's National Center for Space Studies

BOOSTER: Scout

REMARKS: Will be launched by NASA for France in early 1965; more satellites may be developed

GEOS Satellite (NASA)

TYPE: Geodetic satellite

MISSION: Provide a triangulation point in space for determining distances and positions on Earth; continue geodetic measurements of Earth

BOOSTER: Delta (improved)

STATUS: R&D

PRIME CONTRACTOR: Applied Physics Laboratory, Johns Hopkins University

FRAME: Octahedron topped by a truncated pyramid; weight, approximately 360 lbs.

INSTRUMENTATION: Flashing light beacon; range and range rate transponder; Doppler beacon; radio-ranging transponder; Minitrack beacon; satellite clock; corner reflector for laser beam measurements

REMARKS: First launch in last half of 1965

ICBM Alarm (Air Force)

MILITARY DESIGNATION: Redesignated Program 239A (formerly MIDAS)

TYPE: Early warning satellite

STATUS: Re-oriented back in development cycle due to sensor problems

PRIME CONTRACTOR: Lockheed

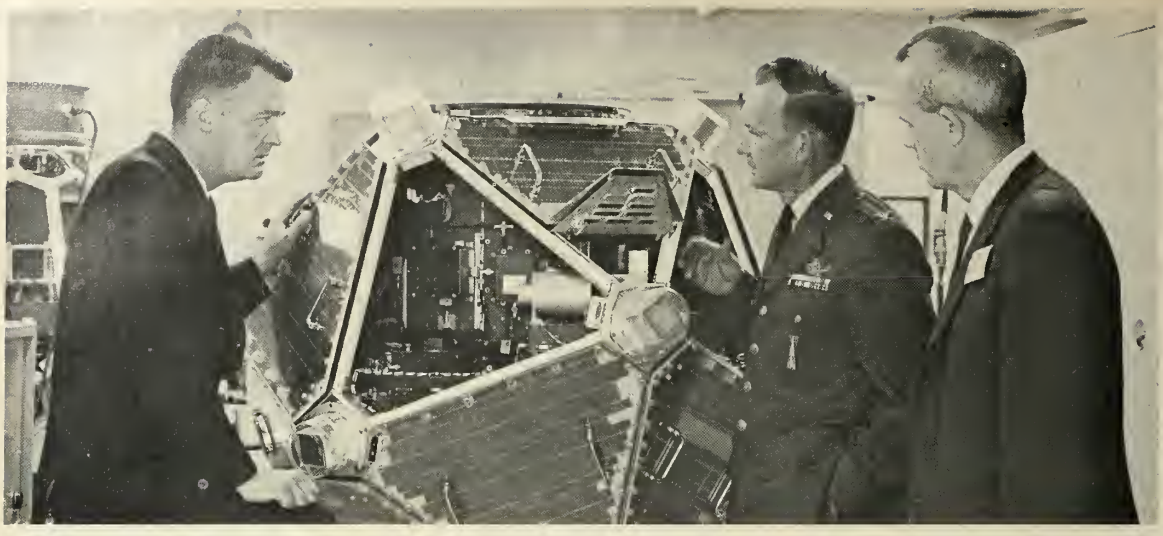
PERFORMANCE: Orbits of 300-3,000 mi.; polar; detects and warns of enemy ballistic missile launches; has had difficulty discriminating launches from other stimulation but some successes were reported in 1963

CONFIGURATION: No details available; program now consists of piggyback payloads

INSTRUMENTATION: Infrared radiation sensors by Aerojet-General

BOOSTER: Can be carried piggyback on various AF boosters

REMARKS: Was open program until secrecy order of March, 1961; orbital system concept changed from one of precise orbits to one of random orbits; a number of in-space detections were made in 1963 of both liquid and solid-fueled ICBM launches from AMR and PMR



NUCLEAR TEST DETECTION SATELLITE

Interplanetary Explorer (IMP) (NASA)

TYPE: Unmanned scientific sotellite

MISSION: 140-lb. sotellite to meosure magnetic fields, cosmic roys ond solor winds between the Eorth ond Moon

STATUS: R&D

PRIME CONTRACTOR: Goddard Spoce Flight Center

POWER UNIT: Solor cells

BOOSTER: Delto

REMARKS: First IMP, Explorer XVIII, launched Nov. 26, 1963, pioneered in mapping the boundory of the Eorth's magnetosphere; the orbit is highly elliptical; the second IMP is scheduled for lounch in lote 1964; five more are plonned ond two of them are to be ploced in orbits oround the Moon

Meteoroid Detection Satellite (NASA)

TYPE: Unmonned scientific sotellite

MISSION: 3,400-lb. satellite to meosure meteoroid density in Eorth orbit, employing two 50 x 15-ft. extendable detector wings

STATUS: R&D

PRIME CONTRACTOR: Fairchld Strotos

BOOSTER: Soturn I

REMARKS: First lounch scheduled for third quorter, 1964; two others to be lounched

ISIS (Canada/ NASA)

TYPE: Unmanned scientific sotellite

MISSION: To study ionosphere os o follow-on to the Alouette sotellite

STATUS: R&D

CONTRACTOR: Conodion Defense Reseorch Boord

BOOSTER: Thrust-Augmented Delto

REMARKS: Three-satellite series, A, B, ond C, will be lounched by NASA beginning in 1967; other shots scheduled for 1968 ond 1969

Nimbus (NASA)

TYPE: Second-generation weother sotellite

MISSION: 750-lb. sotellite in 500-mi. neor-polor Earth orbit

STATUS: R&D

PRIME CONTRACTOR: Goddord Spoce Flight Center; integrotion ond testing, GE

INSTRUMENTATION: RCA vidicon comeras for cloud data; rodiation sensors at vorious resolutions and spectrol ranges for heat balance, temperoture and cloud cover; automotic picture tronsmission system; high resolution infrared radiometer (night-time cloud-cover pictures); odvonced vidicon comero system

POWER UNITS: Solor cells ond batteries

BOOSTER: Agena

REMARKS: Two R&D flights; first, mid-1964

Medium-Altitude Communications Satellite (Air Force)

DESIGNATION: 369

TYPE: Military communications sotellite

STATUS: Early development

PRIME CONTRACTOR: Philco/TRW STL—progrom definition studies

PERFORMANCE: Will orbit at 6,000 mi.; polar; multiple-lounch (in series of 6-8) active repeoter; 24-36 sotellites in orbit simultoneously; weight less than 100 lbs.; ploced in planes 45° oport

PAYLOAD: Norrow bondwidth voice and teletype equipment; onti-jomming equipment

BOOSTER: Atlos-Ageno

SUPPORT EQUIPMENT: Expected to use Advent stotions at Fort Dix, N.J., and Comp Roberts, Colif., ond mobile ground stations develoged by Hughes

REMARKS: Monogement responsibilities: interfoce problems, Defense Communicotions Agency; sotellite system, AF; ground installotions, Army; progrom slipping while DOD negotiotes with ComSat Corp. for use of commerciol system (on DOD terms); progrom definition complete; High-Altitude Synchronous system shelved for now

Nuclear Detection Satellite (ARPA)

TYPE: Detection-sotellite system for nucleor explosions in spoce

STATUS: Development

PRIME CONTRACTOR: TRW STL; sensors, Los Alamos Scientific Laborotory ond Aerospoce Corp.

PERFORMANCE: Operotionol system would consist of three sotellites in one orbitol plone with three more in o plone 90° from the first; orbitol altitude 60,000 n. mi.; con detect x-roys from o one-megoton nucleor explosion at o distonce of 3 x 10^5 km; olso hos other detection equipment for gommo roy detection ond complex memory logic

FRAME: 20-sided satellite for moximum coveroge; weight, 485 lbs.; maximum in dimension, 40 in.

BOOSTER: Atlos-Agena B

REMARKS: Initiol pair of satellites were launched Oct. 17, 1963, in tondem ond placed in virtuolly identical near-circulor orbits; finol positions were such that o constont seporotion of 100,000 mi. is maintoined; remoining 4 poirs of satellites being modified so os not to duplicate first lounch dato

OVERWORKED

(and underpaid!)



COMMAND RECEIVERS

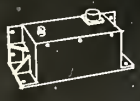
Working in more programs than any other units, Motorola command receivers have logged the most reliable performance hours and miles (at low cost per unit of time and/or distance) in advanced aerospace functions. Off-the-shelf units are used...and often re-used ...on such vehicles as Saturn, Polaris A^2 and A^3, Minuteman, Pershing, Scout, Quail, and Subroc. Special modifications of these units, plus new designs, are specified for a variety of other projects. Motorola command instrumentation is the most frequently selected because the standard line covers a wider range of applications. Motorola's instrumentation group is frequently called on to supply special requirements because of its experience in design and manufacturing to meet advanced specifications. Your range or vehicle requirement can probably be met by standard production units. If not, we can provide the know-how necessary to deliver precisely what you need. Call us.

ON SATURN, Motorola Model MCR-101 shown in illus. above, provides 10 channels, weighs only 2 lbs., 15 ozs.



ON AGENA—MCR-307, the smallest, lightest 3-channel unit made, weighs but 2 lbs.

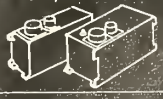
ON POLARIS—MCR-312, features an isolated ground system, supplies 3 decoder channels, weighs 3 lbs.





ON MINUTEMAN—MCR-403, contains 4 decoder channels, weighs 3 lbs., 13 ozs.

ON MERCURY—MCR-102/MAD-101, 20-channel receiver-decoder, worked without a single failure throughout the entire program.



Motorola's Military Electronics Division is also responsible for major electronic subsystems on such programs as Apollo, Gemini, Mariner and Ranger.

Military Electronics Division ***MOTOROLA***

8201 East McDowell Road, Scottsdale, Arizona

Circle No. 2 on Subscriber Service Card



What happens when a turbocharger hits 115,000 RPM?

Trouble. When a turbine wheel spins at 115,000 revolutions per minute—at ambient temperatures up to 1400° F.—almost anything can happen. We had to find out exactly what.

The energy output of modern diesel power packages—widely used in tactical vehicles and at missile sites—has been increased significantly by turbocharging and aftercooling.

Five years ago these turbochargers loafed along at 30,000 RPM—a leisurely pace by today's 50,000 to 70,000 RPM standard. Tomorrow operating speeds of 115,000 will be routine.

To provide metallurgical and design knowledge essential to turbo development, we had to determine what happens when speeds mount to the 115,000 RPM range.

First we had to produce a signal which would indicate both amplitude and frequency of turbine blade vibrations. Long experience with strain gauges came in handy here.

Hold fast at 1400° F.

Then, of course, we had to develop techniques to hold gauges and lead wires securely in position—withstanding terrific heat and large centrifugal forces.

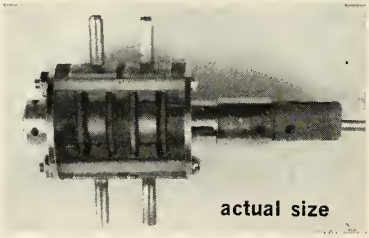
Ceramic-type cements were used to hold the gauges fast. The "armadillo" method was used to shield lead wires.

The toughest problem was transmitting strain signals from the rotating turbocharger assembly to the stationary recording equipment without loss of signal fidelity. Brush-type slip rings were quickly eliminated because of their high noise level.

Fortunately, Caterpillar engineers had pioneered in the development of slip rings using mercury as a conductor between a moving rotor and stationary collecting rings.

The mercury rings had a low noise level. And, because they required only two slip ring channels for each information channel, we were able to reduce the overall size while increasing speed capabilities.

This is what Caterpillar's high-speed mercury slip ring looks like.



Signals from the strain gauges are recorded simultaneously with turbine shaft speeds on a special magnetic tape recorder-reproducer.

This permits us to analyze the frequency and modes of blade vibration—as well as the nature of the vibration, simple or complex. Vibration frequencies of 25,000 cycles a second are not unusual.

Since the time base of the recorded signal can be expanded, high frequency signals can be reduced to a range suitable for recording on light beam galvanometer-type equipment. This method can be used for detailed waveform study when complex vibration modes are experienced.

When the duration of the resonance is long, the recorded signal may be analyzed by obtaining Lissajous patterns on an oscilloscope.

So far, the slip ring and recording equipment have permitted us to measure blade vibrations at speeds up to 86,000 RPM. Test stand data indicates that speeds over 100,000 are possible in the near future.

How about 115,000 RPM?

Our engineers say that it's just a matter of time. Time and patient, thorough research. The kind of research which has become a standard among the engineers, chemists and metallurgists who are exploring tomorrow's unknowns at Caterpillar.

If you need more detailed information about Caterpillar's broad research and development capabilities in the areas of vehicles or diesel engines, write us.

If you have a specific problem in vehicle or power design, or if you'd like to know more about the mercury slip ring, call us.

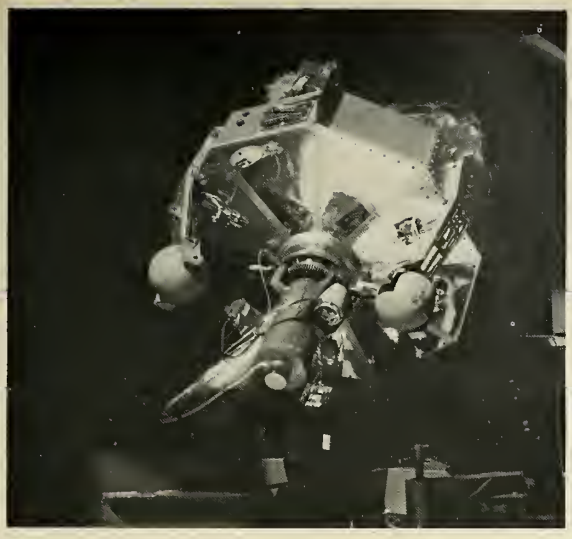
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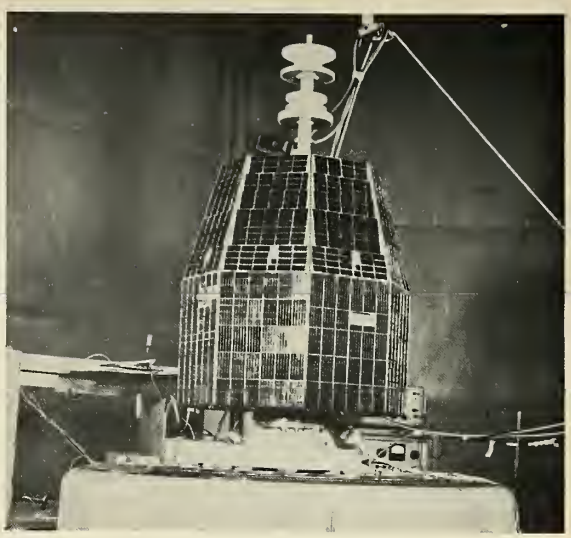
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Circle No. 3 on Subscriber Service Card



OSO



RELAY

Orbiting Astronomical Observatory (NASA)

TYPE: Unmanned scientific statellite

MISSION: 3,600-lb. arbiting sotellite to study ostronomicol phenomeno from obove the otmosphere

STATUS: R&D

PRIME CONTRACTOR: Grumman

GUIDANCE: GE, stobilizotion ond control; IBM, computer; Kollsmon, star trockers

INSTRUMENTATION: Six startrocker telescopes comprise a stellar frame of reference for precision pointing of experiments by ground cammond

BOOSTER: Atlos-Agena

REMARKS: Three approved; first flight scheduled for lote 1965 will study stellar photometry ond spectro and will ottempt a detailed mop of the sky in ultraviolet light; second will carry a 36-in. telescope to photograph spectrum of selected celestial bodies; OAO will be a stondordized space observotory

Orbiting Geophysical Observatory (NASA)

TYPE: Unmanned scientific satellite

MISSION: 1,000-lb. satellite with instruments for geaphysicol measurements, polor ond eccentric orbits plonned

STATUS: R&D

PRIME CONTRACTOR: TRW STL

PERFORMANCE: Capable of accommodoting 20 or more experiments

BOOSTER: Atlas-Agena and Thrust-Augmented Thor

REMARKS: Six launches scheduled; 10 experiments plonned for first flight in third quarter, 1964

Orbiting Solar Observatory (NASA)

TYPE: Unmanned scientific satellite

MISSION: 530-lb. orbiting satellite to study electromagnetic radiations from the Sun

STATUS: R&D

PRIME CONTRACTOR: Ball Brothers

BOOSTER: Delta

REMARKS: First flight Mar. 7, 1962, successful; seven more OSO's ore scheduled, with next launch expected in 1965

Advanced Orbiting Solar Observatory (NASA)

TYPE: Unmanned scientific sotellite

MISSION: 1,200-lb. sotellite to observe a wide ronge of the solar electro-mognetic spectrum with greotly increased pointing occuracy, control flexibility, data-handling capacity ond instrumentotion

STATUS: R&D, Phase I

PRIME CONTRACTOR: Republic

BOOSTER: Thrust-Augmented Thor-Agena

REMARKS: First launch scheduled for lote 1968

Radio Astronomy Observatory (NASA)

TYPE: Unmanned scientific satellite

MISSION: 250-lb. sotellite to investigate cosmic radio noise emanating from galactic sources; launched at an inclinotion of 50 degrees with o circulor 1,240-statute-mi.-high orbit; will carry 750-ft. antennos

STATUS: R&D

CONTRACTOR: None selected

BOOSTER: Delta

REMARKS: May be funded in FY '66 for launch late in 1960's

Relay (NASA)

TYPE: Low-altitude active communication satellite

MISSION: Receive and transmit rodio ond TV signals via the 172-lb. active repeating satellite in an 800 to 4,600-mi orbit

STATUS: Operotional

PRIME CONTRACTOR: RCA

INSTRUMENTATION: Duplicate systems for receiving and re-transmitting widebond TV, telephone ond doto signals; can handle a television transmission or 12 two-way voice channels; radiotion monitoring ond radiation damage detectors

POWER UNIT: Solar cells and batteries

REMARKS: Relay I in orbit Dec. 13, 1962; initial molfunction first apparent on fourth orbit corrected during December; successful use of satellite for experiments ond demonstrations from Jan. 5, 1963, to present invalving ground stotians in U.S., Britain, Fronce, Brazil, Italy, Germany, Jopon and Spain; Reloy II launched Jan. 21, 1964, operoting successfully; no more launches scheduled

SAMOS (Air Force)

MILITARY DESIGNATION: Redesignated Program 720A

TYPE: Reconnaissance satellite

STATUS: Operatianal

PRIME CONTRACTOR: Lockheed; sensors, Eastman Kodak; re-entry capsules, GE; recovery system, Avca & Northrop

CONFIGURATION: Length, 22 ft.; diameter, 5 ft.; weight, 4,100 lbs. with E-5 capsule, 3,000 lbs. with E-6 capsule; weights do not include entire Agena stage

PERFORMANCE: Polar orbit af 100-300 n. mi.; solar cell paddles extend aperating time

INSTRUMENTATION: Photo intelligence equipment by Eastman Kadak

BOOSTER: Atlas-Agena ar Thrust-Augmented Thor

REMARKS: System has highest national priority far recon efforts; cansists apparently af one launch a month; 20-day life far phato equipment aboard; processed film scanned by TV for immediately useful data, then recovered from orbit far detailed analysis after useful life ends; electranic-eavesdropping version known as Ferret picks up communications and carries out electronic intelligence; system credited with giving evidence that "missile gap" was in our favor; major problem naw appears to be a surfeit of useless data

SATAR (Air Force)

TYPE: Scientific satellite

STATUS: Development

MISSION: To provide a law-cost scientific research vehicle far re-entry, prabe and satellite missions

PRIME CONTRACTOR: General Dynamics/Astranautics

CONFIGURATION: A pod maunted on the side of an Atlas booster; length, 55 in.; diameter, 27 in.; weight, 300 lbs. (200-lb. payload); equipped with salid baoster to provide impulse after separatian fram baoster

ORBITS: Depending on paylaad weight, can be placed in orbits varying from 500-2,000 n. mi.; as a re-entry vehicle, attains speeds of up to 30,000 fps

GUIDANCE CONTRACTOR: General Dynamics/Astronautics

GUIDANCE: Strap-dawn system with three orthagonally mounted gyras far displacement and rate data during flight; once in orbit, satellite is unstabilized

BOOSTER: Atlas

REMARKS: Seven vehicles being built under present contract with OAR. Pads af SATAR type have been flown on 44 missions

San Marco (Italy/NASA)

TYPE: Unmanned scientific satellite

MISSION: Approximately 250-lb. satellite to measure aerodynamic drag in an equatorial orbit; will also make ionosphere propagation studies using a beacon

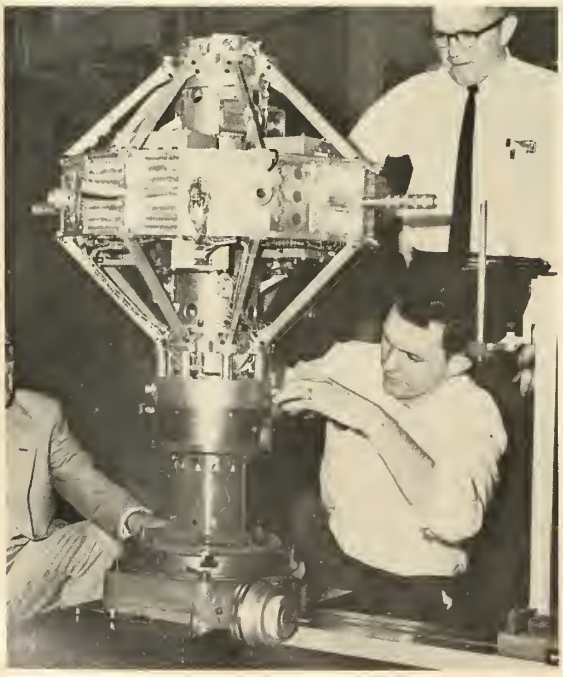
STATUS: R&D

CONTRACTOR: Italian Space Commission

BOOSTER: Scout

REMARKS: Satellite will be launched by NASA from Wallaps Island in early 1965; if it is successful, Italians will then launch the satellite from its off-shore launch platform off the coast af Kenya, Africa, in 1966 or 1967; orbit will be near-circular of 250 to 300-kilometers altitude

SAN MARCO SATELLITE



Satellite Inspector (SAINT) (Air Force)

TYPE: Co-orbital satellite inspection system, Program 706

STATUS: Preliminary design

PRIME CONTRACTOR: Nane

PERFORMANCE: Original pragram was to have been able to detect and rendezvous to within 50 ft. of anather spacecraft or satellite, changing altitude and orbital plane accardingly; however, work an this unmanned vehicle has been suspended

PAYLOAD: Expected ta incarporate TV, optical, infrared radar and radiation sensars

REMARKS: Emphasis is on DOD experiments on Gemini, which may lead to a manned vehicle to perform this mission; ground-based systems are also being emphasized

SECOR (Army)

TYPE: Geodetic satellite

STATUS: Operatianal

MISSION: To provide a reference for ground triangulation of distances

PRIME CONTRACTOR: ITT Labs

CONFIGURATION: Rectilinear, measuring 9 x 11 x 14 in. and weighing 40 lbs.

BOOSTER: Can be carried piggyback on a variety of boosters

TRANSPONDER CONTRACTOR: Cubic Corp.

TRANSPONDER FREQUENCIES: 162-324 mc for geodetic measurements and 54-216 mc for refraction studies

REMARKS: Third launch took place early this year aboard AF secret satellite; project sponsored by Army's Research and Development Laboratories at Fort Belvoir, Va.; used to be an integrated part of ANNA

Synchronous Meteorological Satellite (NASA)

TYPE: Meteorological satellite

MISSION: To provide cantinuous monitoring of short-lived storms and cloud cover and of the whole disc of the Earth

STATUS: Study

PRIME CONTRACTOR: None; study contracts, Republic, RCA, Hughes

PERFORMANCE: 22,300-mi. orbit permits remaining over one point an Earth's surface

INSTRUMENTATION: TV cameras that view the entire Earth and/or selected areas will be used along with suitable radiometers

BOOSTER: Atlas-Agena or Centaur

POWER UNITS: Undetermined

REMARKS: First flights will occur no sooner than 1967; no development funding in FY '65 budget



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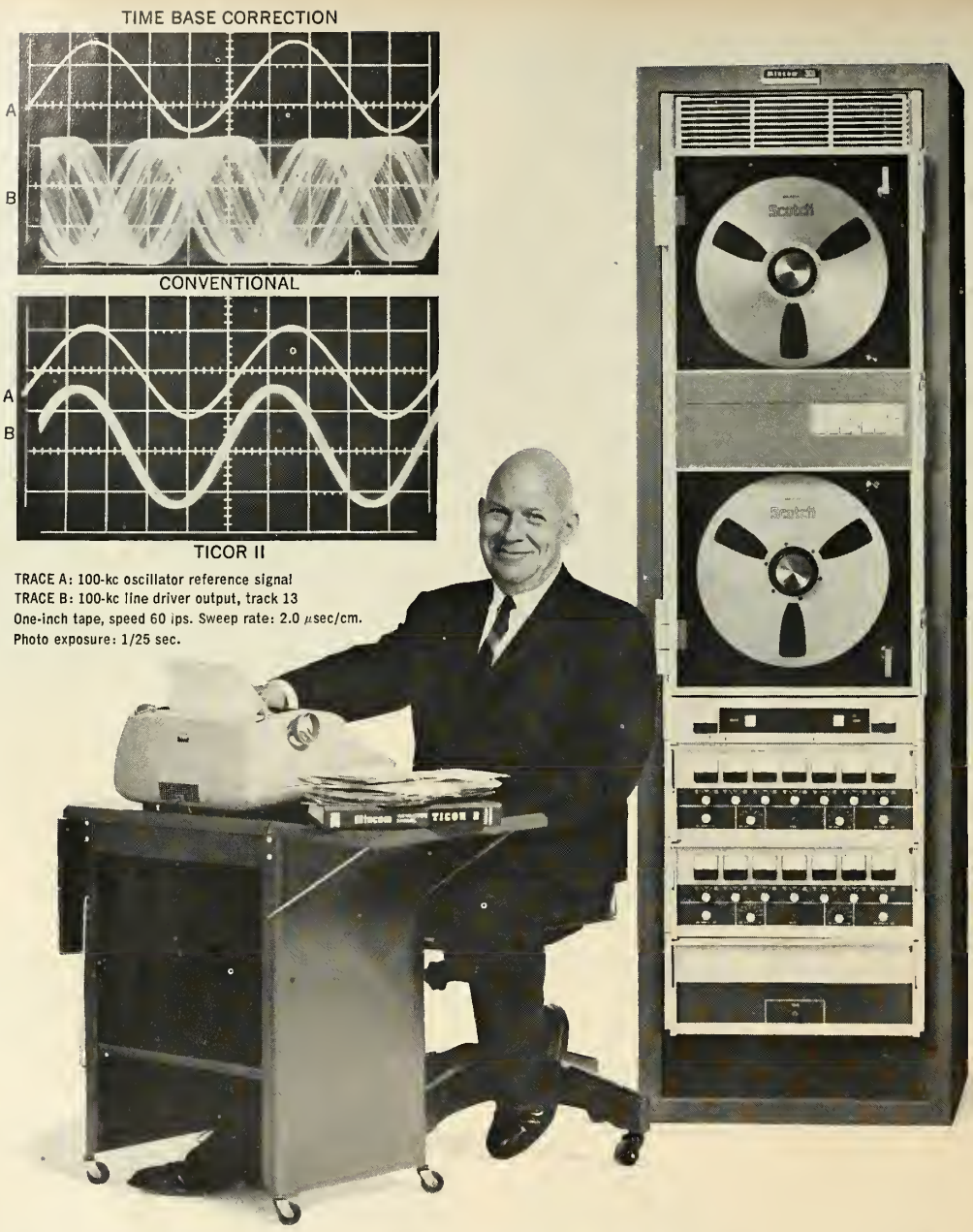
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Syncom (NASA)

TYPE: High-altitude active cammunicatians satellite

MISSION: Receive and transmit signals by way af 63-lb. satellite in a 22,300-mi. orbit

STATUS: Develapment

PRME CONTRACTOR: Hughes

INSTRUMENTATION: Communicatians, antenna, salar sensar, traveling wave tube, nickel cadmium batteries

POWER UNITS: Salar cells

BOOSTER: Delta

REMARKS: First launch into synchranaus arbit an Feb. 14, 1963, but electrical failure an day af launch kept satellite fram aperating; secand launch July 26, 1963; secand satellite still warking and being maved aver Pacific far military experiments; 3rd Syncam ta be launched aver Pacific in time far 1964 Olympics; NASA has aptian an faurth satellite; pragram ends with FY '65

Telstar (AT&T)

TYPE: Law-altitude active communicatians satellite

MISSION: Test braadband micrawave cammunicatians in space; study radiation and micrametearaid effects; test satellite tracking techniques

STATUS: R&D

PRIME CONTRACTOR: AT&T, launched by NASA an reimbursable basis

ORBIT: First flight elliptical inclined 45° ta equatar; 3,500 mi. apagee, 600 mi. perigee; secand flight 6,500 mi. apagee, 500 mi. perigee

CONFIGURATION: Diameter, 34½ in.; weight, 170 lbs.

GUIDANCE: Cammand guidance system—Bell Telephane Labaratories

INSTRUMENTATION: Beacans, cammand receivers, narraw-band PCM-FM-AM telemetry; braadband communicatians

FRAME: Magnesium; framewark shell, aluminum-caated with aluminum axide

POWER UNITS: Nickel-cadium batteries and salar cells

BOOSTER: Delta

REMARKS: First launch, July 10, 1962, successful; warld's first active cammunicatians satellite; successfully received and transmitted TV pictures between America and Eurape; secand launch successful May 7, 1963; Telstar II still transmitting

TRS (Tetrahedral Research Satellite) (Air Force)

TYPE: Scientific satellite

MISSION: Ta measure radiatian in space

STATUS: Operatianal

PRIME CONTRACTOR: TRW STL

CONFIGURATION: Faur-sided, weighing only 3 lbs. and measuring 9 in. an a side

REMARKS: Launched piggyback an a DOD paylaad Oct. 17, 1963; billed as warld's smallest satellite

Tiros (NASA)

TYPE: Meteoralogical satellite

MISSION: 285-300-lb. metearalagical satellite, TV pictures af claud caver; transmits an graund cammand

STATUS: R&D

PRIME CONTRACTOR: RCA

INSTRUMENTATION: Scanning and non-scanning radiatian sensars; narraw-medium- and wide-angle cameras

POWER UNITS: Salar cells and nickel-cadium starage batteries

BOOSTER: Delta

REMARKS: First launch April, 1960; secand, Nav. 23, 1960; third, July 12, 1961; faurth, Feb. 8, 1962; fifth, June 19, 1962; sixth, Sept. 18, 1962; seventh, June 19, 1963; Tiras VIII launched Dec. 21, 1963, carried first automatic picture transmissian system; can transmit ta graund statians anywhere in warld; all flights successful; five mare launches planned thraugh 1965, with Tiras wheel canfiguratian ta serve as interim National Metearalagical System

Transit (Navy)

TYPE: Navigatian satellite

MISSION: Pravide highly accurate positian data ta ships and aircraft an all-weather basis

STATUS: Operatianal evaluatian

DEPLOYMENT: Faur satellites in randam, near-circular arbits at 600-n. mi. altitude

PRIME CONTRACTOR: Applied Physics Lab for Bureau of Naval Weapans

BOOSTER: Thar-Able Star

FRAME: Flat-tapped drum shape, 43 in. diameter, 31 in. high, weighs aver 100 lbs. in final madel; uses gravity-gradient stabilization

INSTRUMENTATION: Electranic clack-memary system, magnetic stabilizatian system, faur transmitters, salar cells and nickel-cadmium batteries

AUXILIARY POWER: Nuclear generatar by Martin

REMARKS: Expected ta greatly reduce position errors for Palaris-firing submarines, ta .1 mile; was first satellite ta use a nuclear pawer generatar; NASA will evaluate far a civilian navigatian system

UK-3 (United Kingdom/NASA)

TYPE: Unmanned scientific satellite

MISSION: Approximately 150-lb. satellite ta measure large-scale naise saurces in the galaxy and the intensity af VLF radiatian

STATUS: R&D

CONTRACTOR: Royal Aircraft Establishment

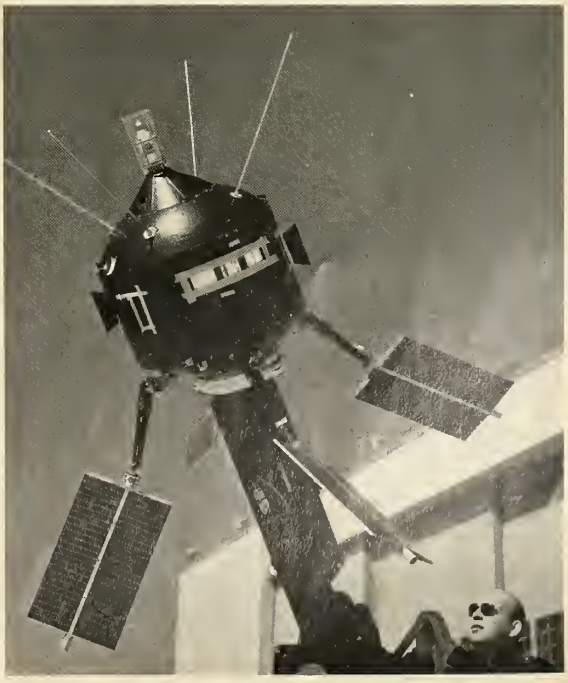
BOOSTER: Scaut

REMARKS: UK-1 and UK-2 were built and launched by NASA successfully an April 26, 1962, and March 27, 1964, respectively; UK-3 will be built by the British but launched by NASA fram Wallaps Island in late 1966; arbit will be near-circular with an altitude af 450 kilometers

TELSTAR



UK-3



Agena D (Air Force)

TYPE: Upper stage

MISSION: Used as upper stage with Thor and Atlas boosters for many programs

STATUS: Operational

PRIME CONTRACTOR: Lockheed

CONFIGURATION: Length variable with payload requirements; 5-ft. diameter; dead weight of 1,700 lbs.; sometimes equipped with solar cell paddles extending from base on scissors-arms; some models have afterskirt covered with solar cells; latter two configurations used on SAMOS and MIDAS

GUIDANCE: All-inertial by Honeywell

PROPULSON SYSTEM: Liquid-propellant rocket originally developed by Bell Aerosystems for B-58 bomber pod; propellants, IRFNA/UDMH; thrust, 16,000 lbs.; restartable at least four times

PERFORMANCE: Depends on booster—with Thor, 1,600 lbs. in 100-n. mi. orbit; with Thrust-Augmented Thor, about 2,500 lbs. in 100-n. mi. orbit; with Atlas D, over 5,000 lbs. in 100-n. mi. orbit; 750 lbs. to escape velocity and 400 lbs. to Mars or Venus; use of Agena with TAT has resulted in cost savings for missions which do not require the full Atlas capability

REMARKS: Used with SAMOS, Discoverer, Ranger, Mariner, OAO, OGO, Tapside Sounder, Nimbus, Echo, Gemini, and other programs; an extremely versatile spacecraft, it is often used for piggyback launches (such as the ham radio satellite, Oscar, and the radiation-data Satellite, TRS-1); also will be used as target vehicle in Gemini program

Atlas-Agena D (Air Force)

TYPE: Space booster

STATUS: Operational

PRIME CONTRACTOR: General Dynamics/Astronautics (Atlas); Lockheed (Agena)

PERFORMANCE: Payload—5,000 + lbs. in 345-mi. orbit, 750 lbs. to escape, 400 lbs. for planetary missions

FRAME: Length—102 ft.; diameter (base)—10 ft.; launch weight—275,000 lbs.

GUIDANCE: System contractor—TRW STL, Agena B; Honeywell, inertial reference

PROPULSION SYSTEM: Booster—Rocketdyne (modified Atlas D); type—liquid; thrust—360,000 lbs.; Agena B—Bell Aerospace; type—liquid; thrust—15,000 lbs.; restart capability

REMARKS: Used in Ranger, Discoverer, MACS, Mariner, Lunar Orbiter, OAO, SAMOS and other space programs



ATLAS-AGENA D

The man who said "you can't take it with you" was born a long time before Garrett started making life support systems.



As a matter of fact, unless man *does* take his earthly environment with him into space, he hasn't got a chance.

For here is a world that has no oxygen, no pressure, no gravity.

To live and work for weeks and months in orbital flight – a need dictated by urgent space projects now in progress – man must have the most sophisticated life support system ever built.

It has to provide him with oxygen, water, pressurization – complete climate control.

It has to guard him against temperatures that range from near absolute zero to the re-entry heat of thousands of degrees.

It has to be a miracle package.

The question becomes: Who is now building such an environmental system?

The answer is, of course, Garrett.

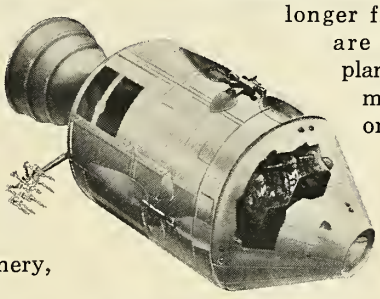
As long ago as 1941, Garrett management saw that man could go no higher, no faster, without pressurization of aircraft. When Garrett's AiResearch division delivered the first systems, suddenly the ceiling was off the world.

Today over 90% of the free world's aircraft carry Garrett environmental systems. Millions of hours of operation have been accumulated by heat transfer equipment, turbomachinery, controls.

This experience led Garrett to build the life support systems that protected our astronauts on the recent Mercury flights.



The same know-how is now at work supplying "shirtsleeve" environments for Gemini and Apollo. These systems will keep man alive for weeks in space. Now longer flights are being planned – manned orbiting



laboratories and space stations. Garrett already knows how to solve life support problems for months in space. Much of the system work is completed and components built.

What are the reasons for this unique capability?

The most experienced men are Garrett men. The most advanced facilities are Garrett. The only applied system for outer space is Garrett built.

When the problem is environmental, the solution comes from Garrett because...

Garrett *is* experience

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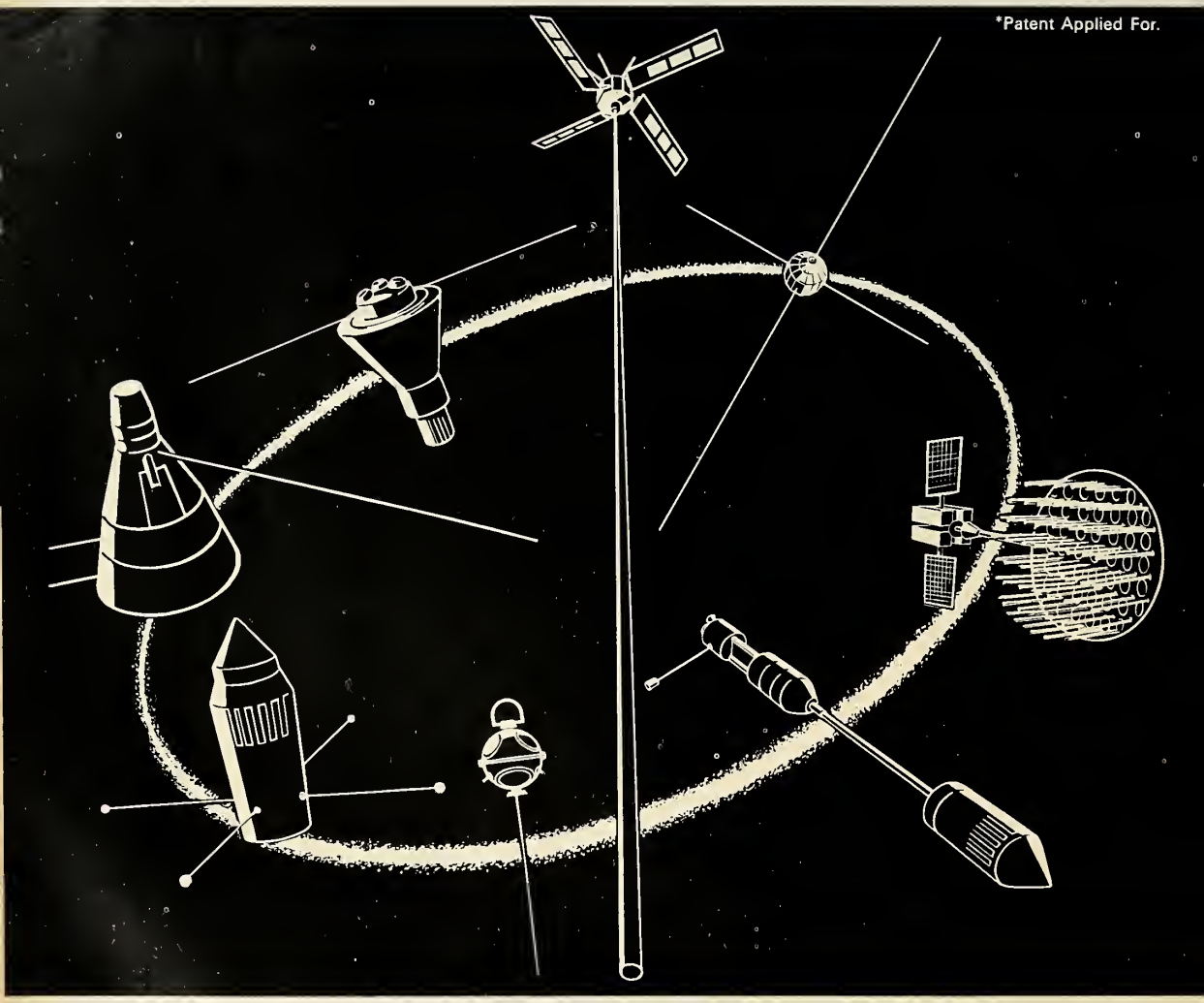
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BREAKTHROUGH IN SPACE

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Here are some of the STEM developments that have contributed to the advancement of space science: communications antenna and arrays in sizes to fit many applications; long gravity gradient orientation booms, and attitude control devices; STEM devices for remote positioning of navigation, communications and instrumentation; high gain antennas and reflectors; extendible coupling and docking devices; and de-spin and stabilization devices.

*Patent Applied For.



De Havilland STEM devices are on these and many other programs; Alouette, LOFTI, NASA Javelin, Scouts, TRAAC, Transit, Gemini, Mercury, POGO.

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Centaur (NASA)

TYPE: Multi-purpose upper stage
MISSION: To launch Surveyor and Mariner spacecraft on lunar and interplanetary missions; will also be used as upper stage for a variety of future space missions

STATUS: R&D

PRIME CONTRACTOR: General Dynamics/Astronautics

CONFIGURATION: Two RL-10 engines developing 30,000 lbs. total thrust; vehicle is 30 ft. long and 10 ft. in diameter

GUIDANCE: Honeywell; type, all inertial

PROPULSION: RL-10 LOX-liquid hydrogen engine, Pratt & Whitney

PAYLOAD: With Atlas D booster, Centaur will place 8,500 lbs. in 345-mi. altitude orbit, 2,300 lbs. to escape velocity and 1,300 lbs. on planetary flights

REMARKS: First flight, May, 1962, failed when LH_2 tank shielding broke off 55 seconds after launch; second launch on Nov. 27, 1963, was successful; the third June 20, 1964, was partially successful meeting all objectives except full-duration burn of the Centaur stage; two more launches are planned for 1964 and six in 1965 when Centaur is scheduled to become operational



CENTAUR

Delta (NASA)

TYPE: Launch vehicle for medium-weight payloads

MISSION: Launch vehicle for Tiros, Echo, Explorer, Telstar and other programs

STATUS: Operational

PRIME CONTRACTOR: Douglas

FRAME: Height, 90 ft.; max. dia., 8 ft.

CONFIGURATION: Three stages

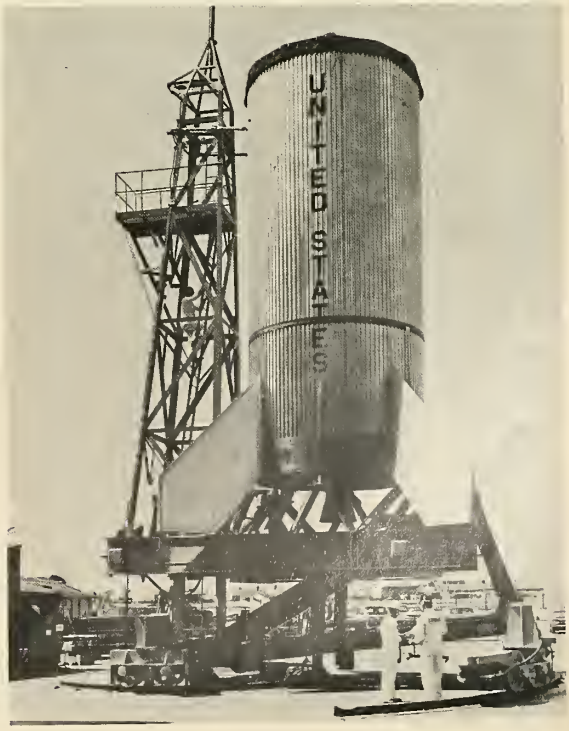
GUIDANCE: Bell Telephone Laboratories

PROPULSION: Liquid-solid: first stage, modified Thor (LOX/RP) (SM-75), thrust 170,000 lbs., Douglas; second, AJ 10-118 (IRFNA/UDMH), thrust, 7,500 lbs., Aerojet; third, Altair II (solid), thrust, 5,700 lbs., Allegany Ballistics Laboratory

PAYLOAD: 800 lbs. in 1,000-mi. orbit; 100 lbs. to escape; Thrust-Augmented Delta (TAD) with three solid-propellant motors strapped to Thor will put 1,000-lb. payload in low Earth orbit and 140 lbs. to escape

REMARKS: Enlarged second-stage fuel tanks planned on eight Deltas will increase burning time from 160 to 400 seconds; some of the eight will use three solid-propellant motors strapped on Thor; the combination will put 1,200 lbs. in low Earth orbit or 225 lbs. into escape velocity

LITTLE JOE II



Little Joe II (NASA)

TYPE: Small solid booster

MISSION: Launch Apollo spacecraft in mission-abort test flights of the launch escape system

STATUS: Operational

THRUST: Up to 735,000 lbs., but varying depending upon number of solid motors and stages used

PRIME CONTRACTOR: General Dynamics/Convair

REMARKS: Two successful flight-tests completed on Aug. 28, 1963, and May 13, 1964; six vehicles ordered; early flights used one 105,000-lb.-thrust Algol rocket and six 34,000-lb.-thrust Recruit rockets; vehicle is sized to take seven Algols for a total thrust of 735,000 lbs.; next flight scheduled for December, 1964

Thrust-Augmented Delta (NASA)

TYPE: Space launch vehicle

STATUS: Development

PRIME CONTRACTOR: Douglas

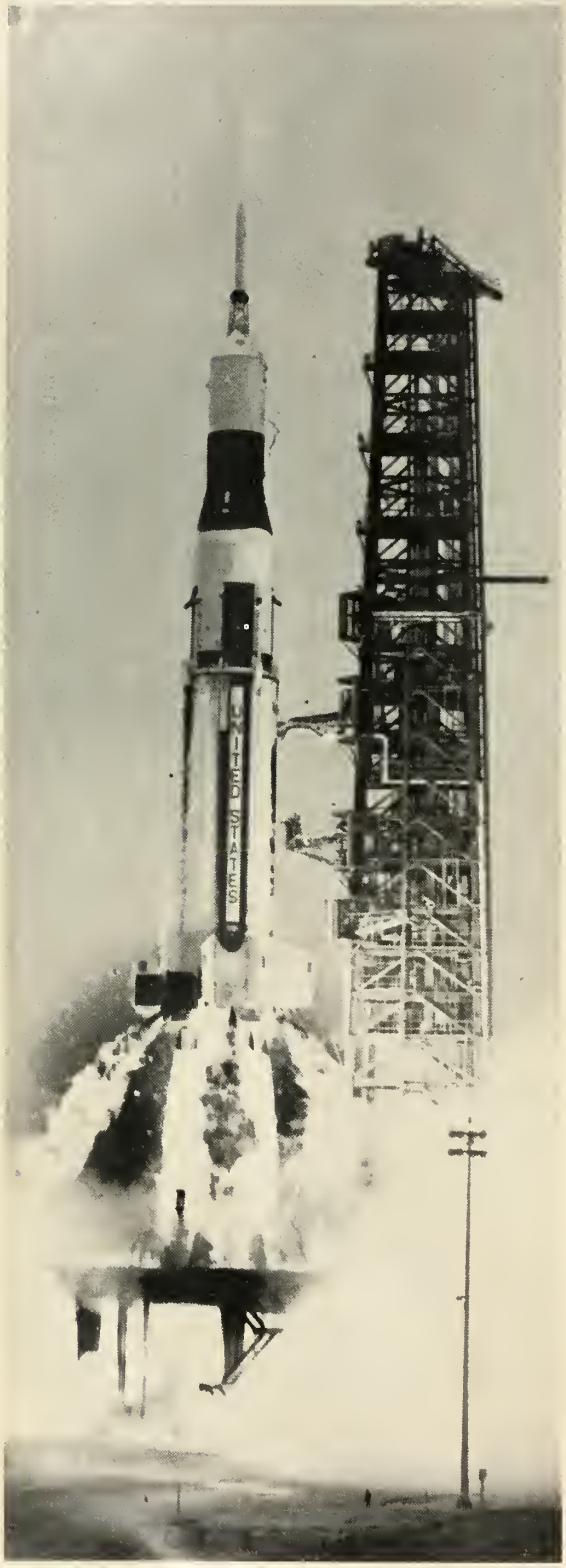
PERFORMANCE: 1,000 lbs. in Earth orbit; 150 lbs. ta escape

CONFIGURATION: Delta launch vehicle with three strap-on solids 120 degrees apart around base

PROPULSION CONTRACTOR: Thiokol for solid motors

PROPULSION: 3 XM-33 solid motors producing 55,000 lbs. thrust each

REMARKS: Initial flight in 1964; will be used for Biosatellite, Pioneer, Syncom, Tiros and CamSat programs



SATURN I

Orion (Air Force)

TYPE: Space propulsion system
STATUS: Feasibility studies and component development
PRIME CONTRACTOR: General Atomics Div., General Dynamics
PERFORMANCE: Capable of placing 1,000 tons in orbit
CONFIGURATION: Classified, but believed to consist of a large energy-absorbing plate or surface mounted on springs behind the vehicle
PROPULSION: Consists of series of small nuclear bombs ejected from rear of vehicle and exploded a short distance behind; energy, both physical and radiative, imparts velocity to vehicle, giving extremely high theoretical specific impulses; feasibility has been proven with high-explosive charges and a sub-scale model, but nuclear test ban treaty hinders further full-scale work
REMARKS: Program dying for lack of support; AF has some money in FY '65 but without a mission is hard put to justify it; NASA-Marshall has shown some interest

Rover (NASA & AEC)

TYPE: Nuclear rocket program
MISSION: High-specific-impulse nuclear stages to lift heavy payloads on lunar and planetary flights
STATUS: R&D
PROPULSION: Los Alamos Scientific Laboratory, reactor research and technology; Aerojet-General and Westinghouse, NERVA engine
REMARKS: Program aimed at providing technology needed for development of nuclear rocket systems for advanced space missions; program currently limited to ground testing; flight-test program with RIFT (Reactor In Flight Test) vehicle not currently funded

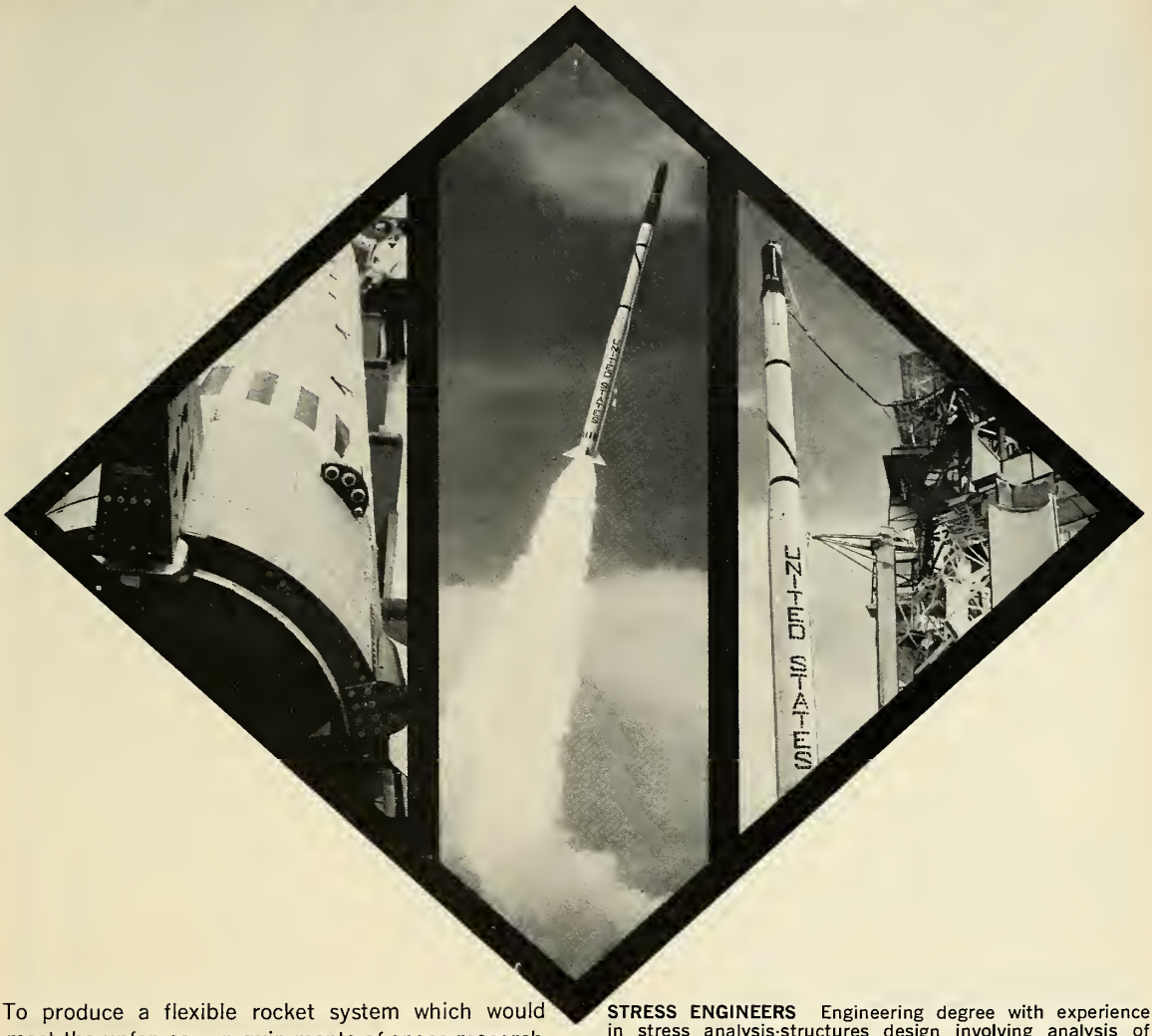
Saturn I (NASA)

TYPE: Two-stage space launch vehicle with 1.5-million-lb.-thrust booster
MISSION: Boost bailerplate Apollo spacecraft in Earth-orbital flights
STATUS: R&D
PRIME CONTRACTORS: S-1 stage, Chrysler; S-IV stage, Douglas
FRAME: 21.6 ft. wide; 125 ft. high
CONFIGURATION: S-1 stage, eight H-1 engines developing 1.5 million lbs. thrust; S-IV stage, six RL-10-A3 engines with 90,000 lbs. thrust
PROPULSION: All liquid; H-1, LOX/RP, Racketdyne; A-3 LOX/H_2, Pratt & Whitney
PAYLOAD: 15,000 lbs. in 345-mi. orbit
REMARKS: First launch (SA-1) Oct. 27, 1961; SA-2, April 25, 1962; SA-3, Nov. 16, 1962; SA-4, March 28, 1963; first launch with live second stage, SA-5, Jan. 29, 1964; SA-6, May 28, 1964; to be operational after 10-vehicle flight-test program, but no missions beyond Apollo flights have been approved.

Saturn IB (NASA)

TYPE: Two-stage space vehicle with 1.5 million lbs. thrust in the booster
MISSION: Boost Apollo spacecraft (including lunar-landing vehicle) models on Earth-orbital flights; also may be used as a supply vehicle in future programs
STATUS: R&D
PRIME CONTRACTORS: S-IB stage, Chrysler; S-IVB stage, Douglas
FRAME: 21.6 ft. dia., 141 ft. high
CONFIGURATION: S-IB stage, eight H-1 engines, total thrust, 1.5 million lbs.; first-stage thrust now being increased to 1.6 million lbs.; S-IVB stage, one J-2 engine, 200,000 lbs. thrust
PROPULSION: All liquid; Racketdyne H-1, LOX/RP; Racketdyne J-2, LOX/H_2
PAYLOAD: 28,500 lbs. in 345-mi. Earth orbit
REMARKS: First flight in 1966; first manned flight in 1967; three-stage Saturn IB with Centaur third stage may be funded in FY '66; will be used to launch Voyager spacecraft

GOINGEST ROCKET AROUND



To produce a flexible rocket system which would meet the unforeseen requirements of space research, LTV Astronautics called on its experienced engineering team and backed them with the extensive research, engineering and manufacturing facilities of the rest of the LTV family of divisions. The result? SCOUT, a launch vehicle based on several off-the-shelf stages which can be combined into the precise system needed for the job at hand whether it be deep space probe, orbital mission, or hypersonic atmospheric re-entry. With numerous launches to its credit, SCOUT has amassed an impressive reliability record and made significant contributions — first solid-fueled rocket to orbit a scientific payload and selected to perform space missions for France, England and Italy. ■ LTV Astronautics and LTV Vought Aeronautics have responsible positions for inventive engineers like those who designed and developed SCOUT. Some of the career areas include:

STRESS ENGINEERS Engineering degree with experience in stress analysis-structures design involving analysis of structural integrity of major components or secondary structures on aircraft and missiles.

SOLID AND LIQUID PROPULSION Experience in conducting analysis, defining requirements, specifications, performance and tests of liquid propulsion systems, subsystems and components including hydrogen peroxide applications on SCOUT and other space systems. Solid rocket systems design in vehicle application, testing and processing criteria.

AERODYNAMICS Experience in aircraft and missile performance analysis including drag calculation, rates of climb, stability and control, and evaluation of range and cruise limitations.

CONTROL SYSTEMS DESIGN Requires experience in the design of aircraft or missile control systems with emphasis on electro-mechanical components and systems.

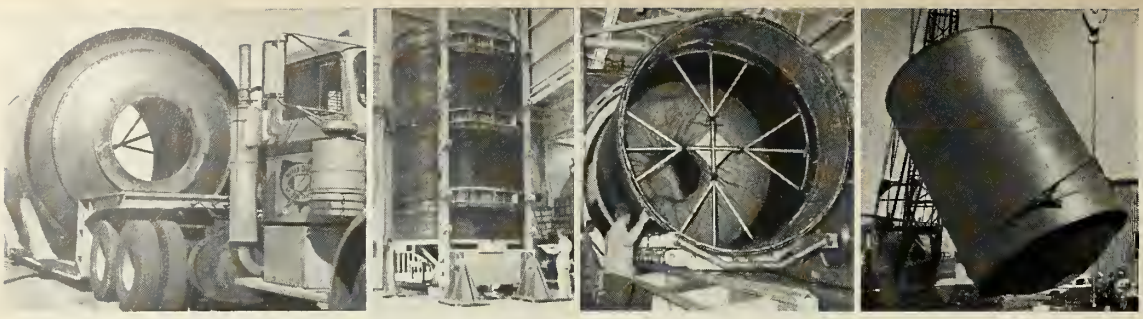
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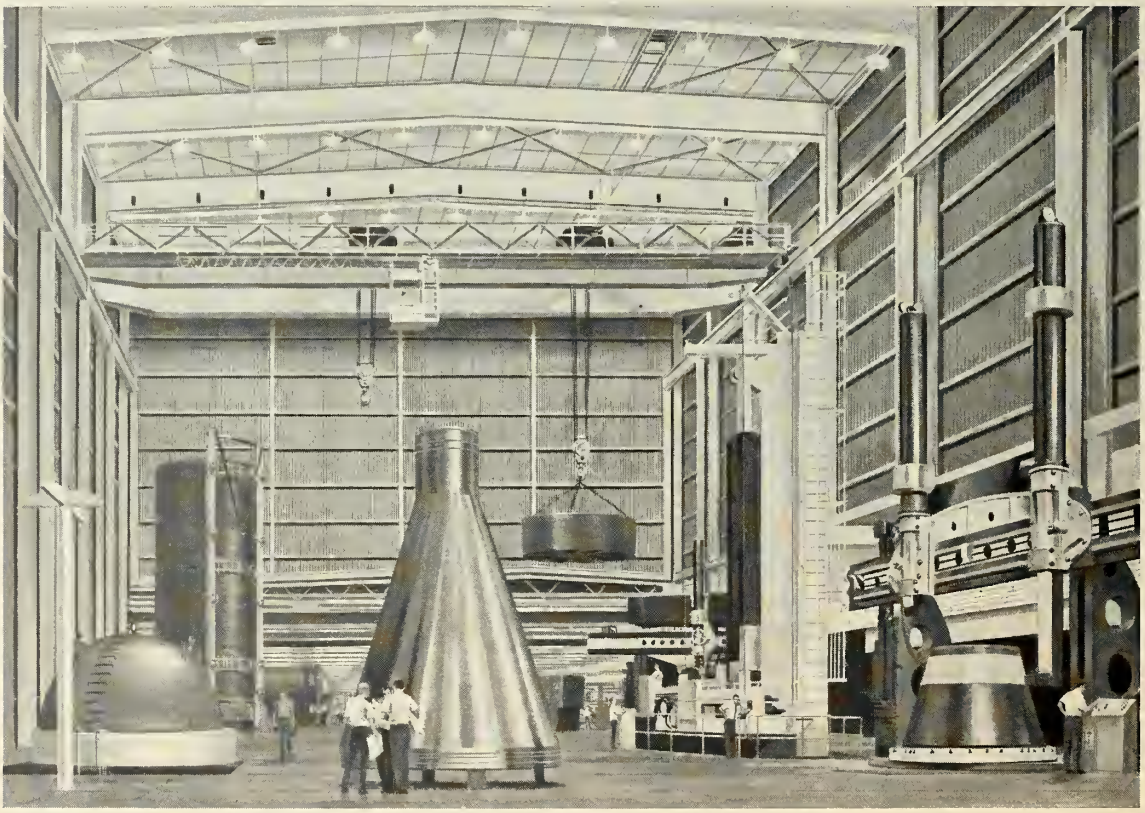
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SPACE PRODUCTS DIVISION

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Saturn V (NASA)

TYPE: Three-stage space launch vehicle with 7.5-million-lb.-thrust booster stage

MISSION: Prime booster for the first manned lunar-landing mission using the lunar-orbit rendezvous method; under study as booster for space station

STATUS: R&D

PRIME CONTRACTOR: S-IC stage, Boeing; S-II stage, North American; S-IVB stage, Douglas

FRAME: 33 ft. diameter; 275 ft. high

CONFIGURATION: S-IC stage, 5 F-1 engines, total thrust 7.5 million lbs.; S-II stage, 5 J-2 engines, total thrust 1 million lbs.; S-IVB stage, 1 J-2 engine, total thrust 200,000 lbs.

PROPULSION: All liquid; F-1 liquid oxygen/kerasene engine, Rocketdyne; J-2 liquid hydrogen/liquid oxygen engine, Rocketdyne

PAYLOAD: 220,000 lbs. in 345-mi. Earth orbit; 90,000 lbs. escape; 70,000 lbs. planetary

REMARKS: First flight scheduled for 1967; engines for 10 vehicles already under contract

Post-Saturn V Launch Vehicles (NASA)

TYPE: Multimillion-lb.-thrust space boosters

MISSION: Lunar exploration and manned planetary flights

STATUS: Under study

CONTRACTORS: Many study contracts awarded

PAYLOAD: Two-and-half to three times the 20,000-lb. payload of Saturn V

REMARKS: No hardware funding expected until FY '68; concepts studied include new high-pressure liquid engines, 156-in. and 260-in.-dia. solid motors, nuclear-powered stages and various combinations of solid, liquid and nuclear propulsion

Scout (NASA)

TYPE: Launch vehicle for small payloads

MISSION: Booster for NASA scientific satellites, suborbital research missions and international satellites

STATUS: Operational

PRIME CONTRACTOR: Ling-Temco-Vought

CONFIGURATION: 40-in. maximum diameter, 72 ft. high

GUIDANCE: Honeywell; type, inertial reference

PROPULSION SYSTEM: All solid; first stage, Algol, Aerojet-General; second, Castor, Hercules; third, Antares II, Allegany Ballistics Lab; fourth, Altair II, ABL

PAYLOAD: More than 200 lbs. in 300-mi. orbit

REMARKS: Operational; used by NASA to launch small payloads such as Explorers; 23 more on order

Thor-Able Star (Air Force)

TYPE: Space launch vehicle

STATUS: Operational

PRIME CONTRACTOR: Douglas

PERFORMANCE: 900 lbs. in 100-n. mi. orbit

CONFIGURATION: Length, 55.9 ft., diameter, 8 ft., launch weight, 118,200 lbs., height 79 ft.; Thor (DM-21) first stage; Able Star second stage

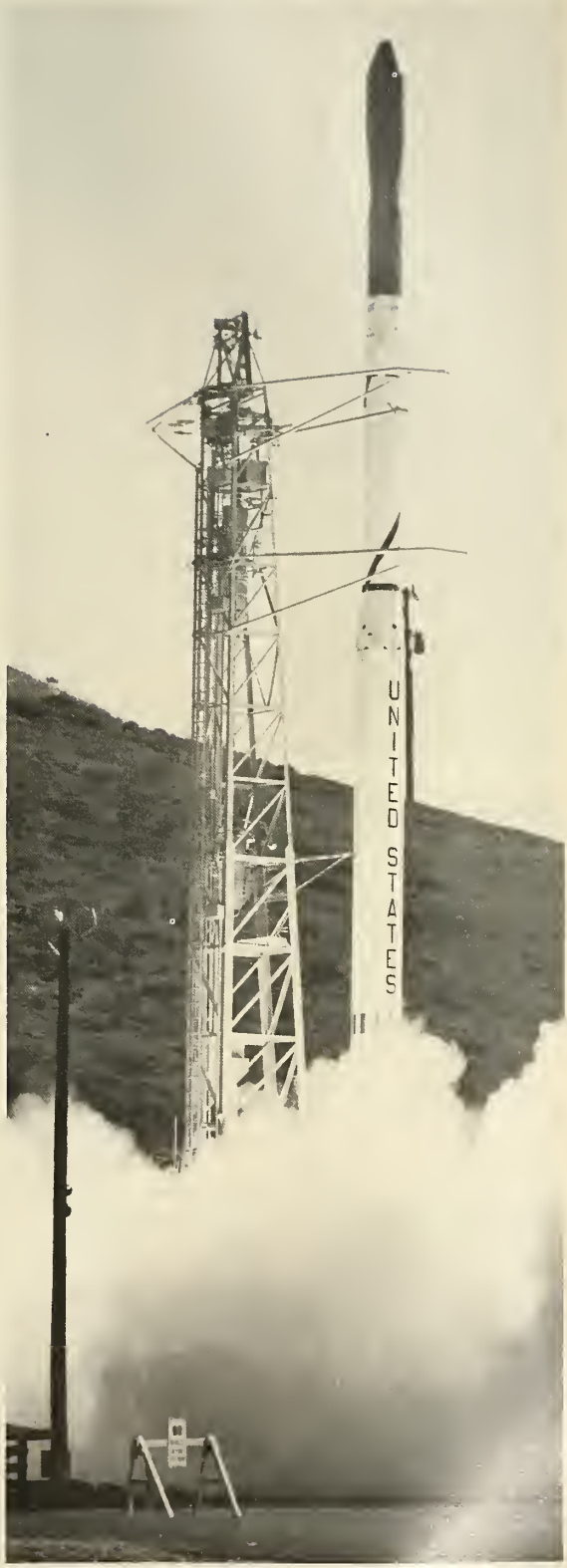
GUIDANCE CONTRACTOR: Bell Telephone Labs

GUIDANCE: Radio command for both stages

PROPULSION CONTRACTOR: Rocketdyne, first stage; Space-General, second

PROPULSION: RP/LOX first-stage producing 172,000 lbs. thrust; vernier engines on booster provide 2,000 lbs. thrust additional; UDMH/IRFNA second stage producing 7,900 lbs. thrust

REMARKS: Restart capability; used in Transit and other military programs



SCOUT

Thor-Agena D (Air Force and NASA)

TYPE: Space launch vehicle

STATUS: Operatianal

PRIME CONTRACTOR: Nane

PERFORMANCE: Paylaad—1,600 lbs. in 300-mi. arbit

FRAME: Manufacturers—Douglas, Thar; Lockheed, Agena D; length averall 76 ft. (less spacecraft); diameter—8 ft.; launch weight about 123,000 lbs.

PROPULSION: All-liquid, Rocketdyne, 172,000 lbs. thrust

GUIDANCE: Thor, Bell Telephone Labs; Agena D, Haneywell; type: Thor, radio; Agena, all-inertial

STAGES: 1, madified Thor IRBM, Douglas; Rocketdyne engine; 2, Agena, Engine-Bell XLR-81, Bell Aerospace; Agena vehicle, Lockheed

REMARKS: Used in Air Force space program; NASA has used in Telstar, Topside Saunder satellite and ather programs; eleven NASA launches scheduled

Thrust-Augmented Thor (TAT) (Air Force/ NASA)

TYPE: Space launch vehicle

STATUS: Operational

PRIME CONTRACTOR: None

PERFORMANCE: 2,500 lbs. in 100-n. mi. orbit

FRAME: Three strap-an salids located 120° apart at base of Thor; remaining stages same as Thor-Agena

PROPULSION: Thor, liquid, 172,-000 lbs. of thrust; each strap-on has 55,000 lbs.

PROPULSION CONTRACTOR: Thor, Rocketdyne; solid, Thiokol

REMARKS: TAT, designated SLV IIC, is used by AF and NASA to orbit payloads too heavy for the Thor, but which would not utilize all the capacity af Atlas; NASA will use for Pogo and Nimbus launches

Titan II (GLV) (NASA)

TYPE: Manned space booster

STATUS: Develapment

PRIME CONTRACTOR: Martin

CONFIGURATION: Essentially same as Titan II missile, with addition af redundant electrical power and flight control systems, a malfunction detection system to warn of abort situatians and a radio command guidance system such as that used in Mercury

REMARKS: GT-1, an unmanned version of Gemini launch system, was successfully launched into orbit from Cape Kennedy on April 8; GT-2, a ballistic flight, planned for August ar September

Titan III (Air Force)

MILITARY DESIGNATON: Program 624A

TYPE: Standard space baoster far quick-reaction military missians

STATUS: Development

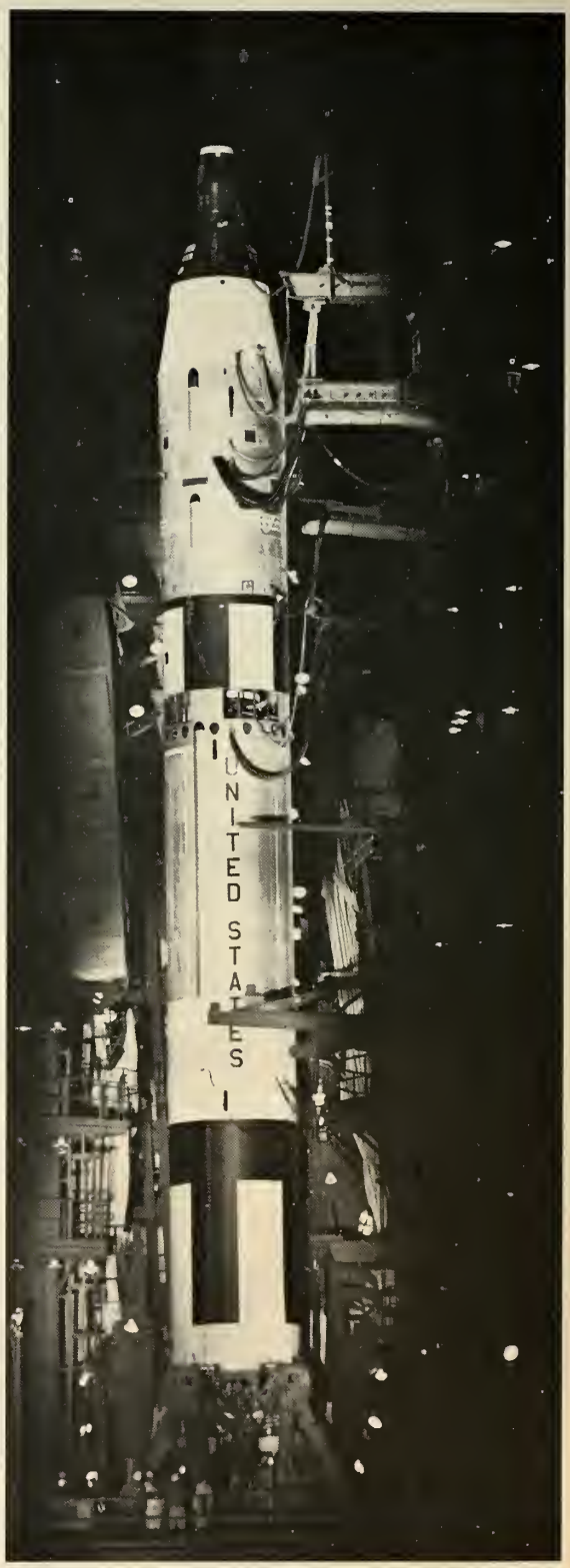
CONTRACTORS: Martin, systems integration; UTC, large solid rackets; Martin, Titan II care vehicle; Aerojet, liquid rocket propulsion; AC Spark Plug, guidance

PERFORMANCE: Capable af placing 5,000-25,000 lbs. in low Earth orbits or 2,100 lbs. in synchronous arbits, depending an configuration

PROPULSION: Core vehicle—two liquid racket engines with 430,000 lbs. thrust total; one liquid rocket engine with 100,000 lbs. thrust, and twa liquid rocket engines with 8,000 lbs. thrust each; "outboard motars" of two salid rockets, each 120-in.-dia. generating over 2,-000,000 lbs. thrust total and weighing 500,000 lbs. each

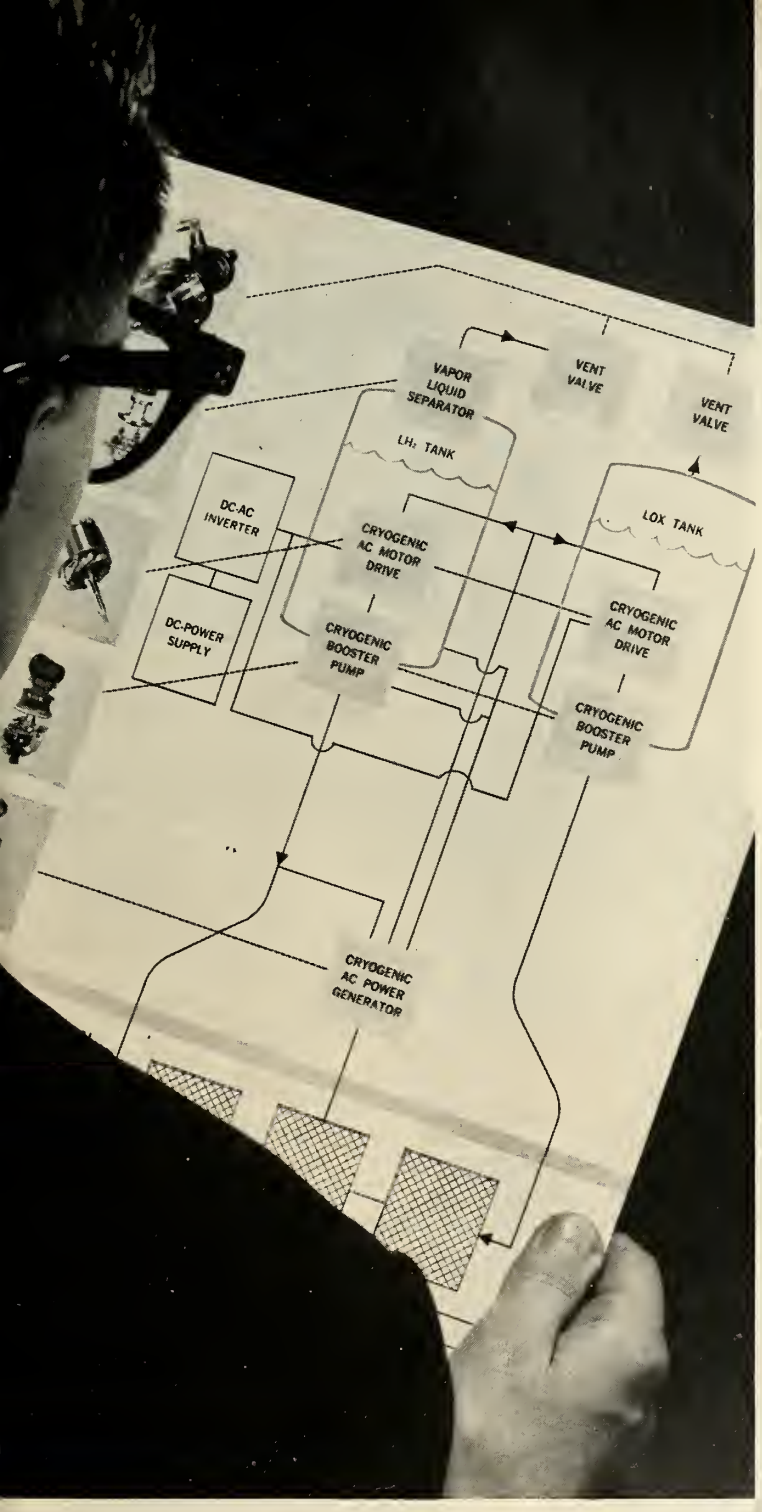
CONFIGURATION: Titan IIIA is core vehicle (modified Titan II) with third (trans) stage; Titan IIIC is full vehicle, using both autboard solid rockets; configuration used depends on mission parameters

REMARKS: First flight of Titan IIIA expected September, 1964; first Titan IIIC flight expected January, 1965; 17 development flights planned—5 Titan IIIA and 12 Titan IIIC; boaster far MOL and possibly MACS; will carry scientific payloads on R&D flights



TITAN II GLV

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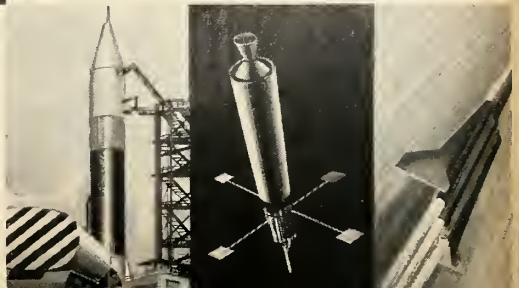
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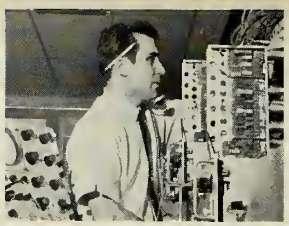


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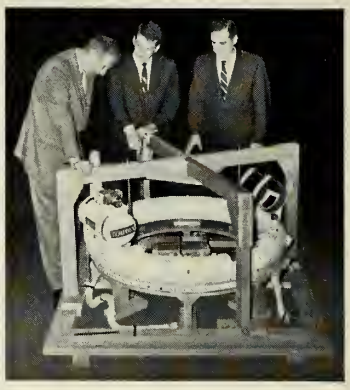
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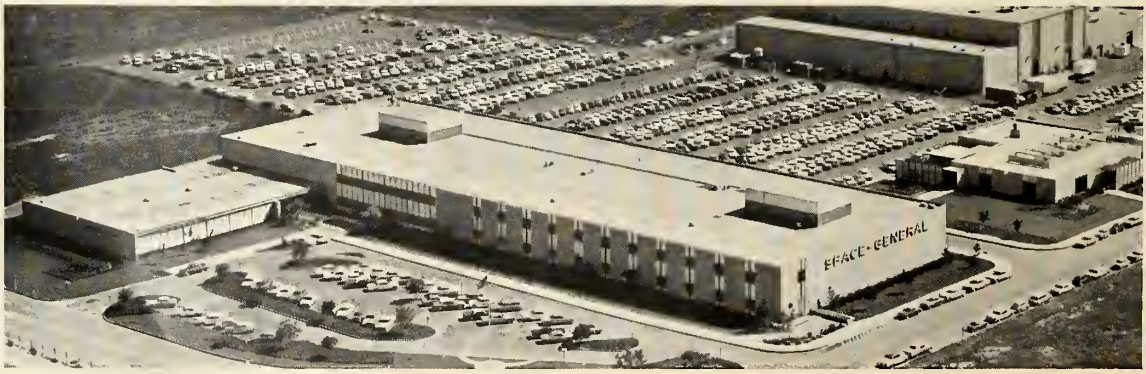
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Agena

MANUFACTURER: Bell Aeraspace
MANUFACTURER'S NUMBER: XLP-81-BA-5, -7 and -9
PROPELLANTS: RFNA and UDMH
NOZZLE MATERIAL: Uncaaled titanium
LENGTH: 7 ft.
WIDTH: 3 ft.
WEIGHT: 300 lbs.

START SYSTEM: Salid prapellant
IGNITION: Hypergalic
PROPELLANT SUPPLY: Turbapump, single restart
AVERAGE THRUST: 16,000 lbs.
BURNING TIME: Tank capacity
STATUS: Operatianal—ta be used with OGO, Nimbus and USAF Agena vehicles; alsa target vehicle far Gemini rendezvaus with added multiple restart feature

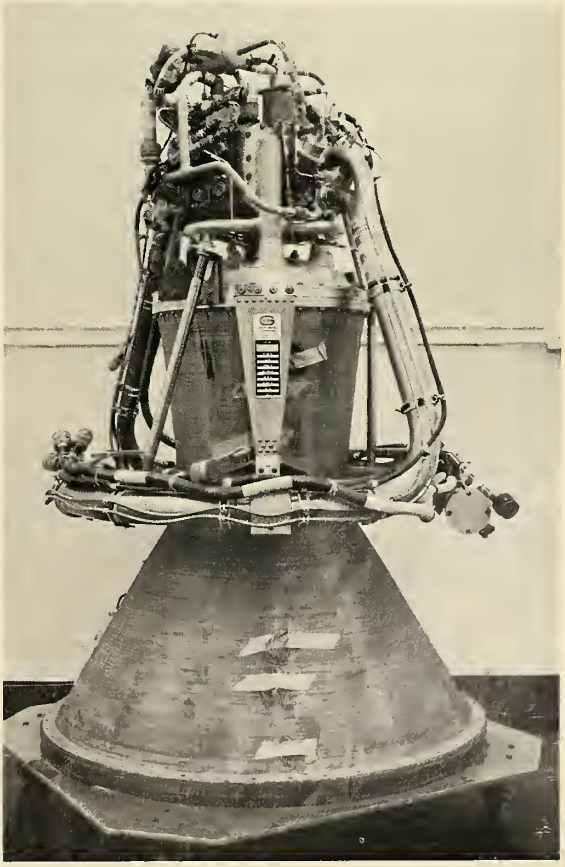
Apollo Service Module

MANUFACTURER: Aerajet
MANUFACTURER'S NUMBER: AG10-137
PROPELLANTS: Aerazene-50, nitragen tetraxide, starable
NOZZLE MATERIALS: Thin welded titanium and calumbium
NOZZLE EXP. RATIO: 60:1, high altitude

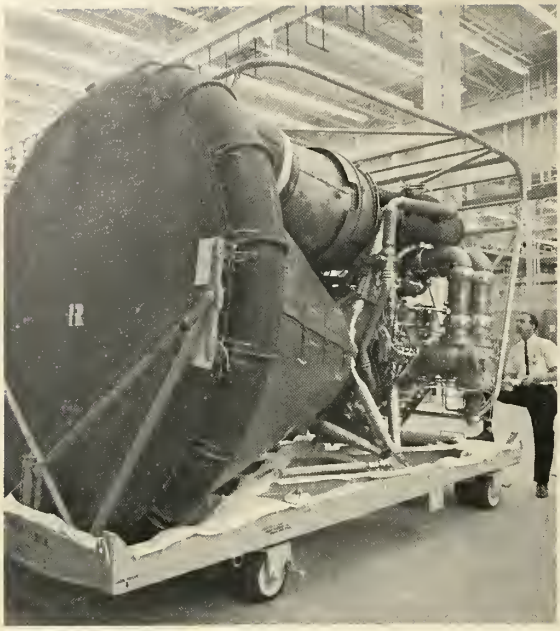
LENGTH: 152.8 in.
WIDTH: 98.4 in.
IGNITION: Hypergalic
PROPELLANT SUPPLY: Pressure-fed
AVERAGE THRUST: 21,900 lbs. restart
STATUS: Under develapment; unit will pravide prapulsian far the Apalla service madule ta and fram the Maan, in and aut af lunar arbit and inta the carrect Earth re-entry windaw

Apollo Command Module Reaction Control System Engines

MANUFACTURER: Racketdyne
MANUFACTURER'S NUMBER: SE-8
STATUS: Under develapment



APOLLO SERVICE MODULE ENGINE



F-1

Gemini Orbital Attitude Maneuvering System

MANUFACTURER: Racketdyne
MANUFACTURER'S NUMBER: SE-7
PROPELLANTS: Storable liquids
NOZZLE MATERIAL: Ablative
START SYSTEM: Hypergolic
BURNING TIME: From several milliseconds to severol minutes
STATUS: In production; 16 used on each capsule

Gemini Orbital Re-entry Control System

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER: SE-6
PROPELLANTS: Storable liquids
NOZZLE MATERIAL: Ablotive
START SYSTEM: Hypergolic
BURNING TIME: From several miliseconds to severol minutes
STATUS: In production; 16 used on eoch copsule

H-1 Engine

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER: H-1
PROPELLANTS: LOX, kerosene
NOZZLE CONFIG. & EXP. RATIO: Bell; 8:1; regen. cooled
NOZZLE MATERIAL: Stainless steel
LENGTH: About 8 ft.
WIDTH: 50 in. (Moximum)
WEIGHT: About 1,400 lbs.
START SYSTEM: Salid prapellant
IGNITION: Pyropharic
PROPELLANT SUPPLY: Turbopump
MAXIMUM THRUST: 188,000 lbs. uprated to 200,000
SPECIFIC IMPULSE: 255 sec. (seo level)
BURNING TIME: Tank copocity
STATUS: Cluster of 8 designed for Saturn I and IB

Atlas Booster

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER: MA-2, MA-3, MA-5 (booster-LR90 NA-5; sustainer, LR105NAO)
PROPELLANTS: LOX, RP-1
NOZZLE MATERIAL: Nickel
NOZZLE CONFIG. & EXP. RATIO: Bell, regen. coaled, 8:1
LENGTH: About 8 ft.
WIDTH (MAXIMUM): (one engine) 60 in.
WEIGHT (one engine): 1,418 lbs.
START SYSTEM: MA-2-LOX-kerosene gas generator; MA-3, solid prapellont
IGNITION: MA-2, pyratechnic; MA-3, pyrophoric
PROPELLANT SUPPLY: Turbapump —twin pumps operated by single turbine for each chamber
AVERAGE THRUST: MA-2, 370,000 lbs.; MA-3, 389,000 lbs.; MA-5, 388,200 lbs., ot sea level
BURNING TIME: 120 sec.
STATUS: Atlas missile; Atlos-Agena; Atlos-Centaur; systems under experimentol modification to handle FLOX/RP-1 mixture

J-2

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER: J-2
PROPELLANTS: LOX, liquid hydragen
AVERAGE THRUST: 200,000 lbs.
BURNING TIME: Tank copocity
STATUS: Sloted for Soturn IB and V

Delta— Second Stage

MANUFACTURER: Aerojet
MANUFACTURER'S NUMBER: AJ10-118
PROPELLANTS: IRFNA and UDMH
LENGTH: 190 in.
WIDTH: 32 in. (max.)
WEIGHT: 645 lbs.
IGNITION: Hypergalic
PROPELLANT SUPPLY: Pneumatically pressurized tanks
AVERAGE THUST: 7,500 lbs.
BURNING TIME: Tank capacity
STATUS: Thar-Delta scientific satellite launch vehicle

Lunar Excursion Module

(Two under porollel development)
DEVELOPER: Rocketdyne
PROPELLANT: Hypergolic
NOZZLE CONFIG.: Bell, radiation skirt
START SYSTEM: Hypergalic
THRUST: Deep throttling develaping 10,500 lbs. in o vocuum at full thrattle and 1,050 lbs. ot minimum
REMARKS: Engine ond maunt gimbolled ± 6 degrees by meons af vehicle-mounted gimbal octuotars to provide trim control in pitch ond yaw axes during pawer descent; helium injection fixed oreo injector
DEVELOPER: TRW STL
MANUFACTURER'S NUMBER: MIRA 10500
PROPELLANT: N_2O_4 Aerazine 50
NOZZLE CONFIG. AND EXP. RATIO: Bell; 48:1
IGNITION: Hypergolic
PROPELLANT SUPPLY: Pressure-fed
THRUST: Throttleable from 10,500 lbs. to 1,050 lbs.
BURNING TIME: 730 sec.
REMARKS: One of twa under development (ather at Racketdyne)

F-1

MANUFACTURER: Racketdyne
MANUFACTURER'S NUMBER: F-1
PROPELLANTS: RP-1, LOX
NOZZLE CONFIG. & EXP. RATIO: Mad. bell; greater than 12:1; regen. cooled
LENGTH: About 20 ft.
WIDTH: About 12 ft.
WEIGHT: Abaut 20,000 lbs.
START SYSTEM: Solid propellant
IGNITION: Electric spark
PROPELLANT SUPPLY: Turbopump
AVERAGE THRUST: 1.5 million lbs.
SPECIFIC IMPULSE: About 260 sec. (sea level)
BURNING TIME: Tank capocity
STATUS: Production engines being delivered ta NASA and slated for Saturn V in cluster of 5 engines

M-1

MANUFACTURER: Aerojet-General
PROPELLANTS: LOX, liquid hydragen
NOZZLE: upper stoge DeLavol type, gas cooled
START SYSTEM: gas generator
IGNITION: electric spark
PROPELLANT SUPPLY: Dual turbopumps (ane per prapellont); fuel pump is a two-stage unit
THRUST: 1:5 millian lbs.
STATUS: First static test June 20, 1964; PFRT in 1967; ond first flight in 1969 at the earliest



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R/M

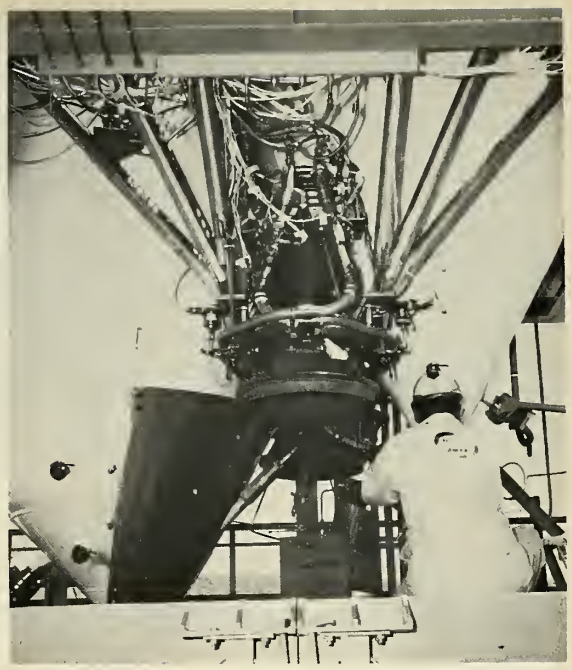
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NERVA

TYPE: Nuclear Rocket Engine
MISSION: Development of experimental nuclear racket propulsion system
STATUS: R&D
PRIME CONTRACTOR: Aerojet-General Corporatian
PROPULSION SYSTEM: Aerojet—overall system responsibility and development of non-nuclear hardware; Westinghause Astra-nuclear Laboratory—development of nuclear reactor for engine based upon basic work performed by Las Alamos Scientific Laboratory
REMARKS: Joint NASA-AEC program with current objective of providing technology for first-generation nuclear rocket engine through ground system tests; first NERVA reactor experiment scheduled for late this year

RL-10

MANUFACTURER: Pratt & Whitney
MANUFACTURER'S NUMBER: RL-10
PROPELLANTS: LOX, liquid hydrogen
NOZZLE CONFIG. & EXP. RATIO: Mod. bell; 40:1
IGNITION: Exciter-spark
PROPELLANT SUPPLY: Bootstrap-hydrogen gas-driven turbopump
THRUST: 15,000 lbs.
SPECIFIC IMPULSE: 433 (nominal, in vacuum)
BURNING TIME: Tank capacity
STATUS: Operational multiple-start upper-stage propulsion system for major space missions on Centaur and Saturn S-IV; advanced configuration capable of being fired in low-thrust mode on tank pressure, operating on either gaseous, mixed-phase or liquid propellants prior to acceleration to rated thrust; engine has demonstrated throttled operatian from 100% to 10% of rated thrust



TITAN III TRANSTAGE

Surveyor Vernier Engine

MANUFACTURER: TRW STL
MANUFACTURER'S NUMBER: MIRA 150A
PROPELLANTS: N_2O_4 and MMH
NOZZLE CONFIG. & EXP. RATIO: 70% bell; 32.3 exp. ratio
IGNITION: Hypergolic
PROPELLANT SUPPLY: Pressure-fed
THRUST: Throttleable from 150 lbs. down to 30 lbs.
BURNING TIME: 300 sec.
REMARKS: Capable of restart in space; engine has ablative chamber, hard throat, and titanium extension skirt; three engines per spacecraft

Titan I Booster

MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: LR-B7-AJ-3
PROPELLANTS: LOX, Kerosene
NOZZLE MATERIAL: nickel
NOZZLE CONFIG. & EXP. RATIO: Bell; 8:1; regen. cooled
LENGTH: About 10 ft.
WIDTH: About 9 ft. (max.)
WEIGHT: About 3,700 lbs.
START SYSTEM: Ground-supplied
IGNITION: Pyrotechnic
PROPELLANT SUPPLY: Turbopump
AVERAGE THRUST: 300,000 lbs.
BURNING TIME: 120 secs.
REMARKS: (See Titan I in missile section)

Titan II—1st Stage

MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: YLR-B7-AJ-5
PROPELLANTS: Nitrogen tetroxide; Aerozene-50 (50-50 mixture UDMH & hydrazine)
NOZZLE CONFIG. & EXP. RATIO: Bell; regen. cooled; 8:1
START SYSTEM: Bootstrap
IGNITION: Hypergolic
PROPELLANT SUPPLY: Turbopump
AVERAGE THRUST: 430,000 lbs. (two barrel)
BURNING TIME: Tank capacity
REMARKS: (See Titan II in missile section)

Titan II—2nd Stage

MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: YLR-91-AJ-5
PROPELLANTS: Nitrogen tetroxide, Aerozene-50
NOZZLE CONFIG. & EXP. RATIO: Mod. bell; 45:1; regen. cooled
START SYSTEM: Bootstrap
IGNITION: Hypergolic
PROPELLANT SUPPLY: Turbopump
THRUST: 100,000 lbs., single-barrel
BURNING TIME: Over 3 minutes in Gemini Use
REMARKS: Man-rated for Gemini launch applications

Titan III—Engines

MANUFACTURER: Aerojet-General
REMARKS: Titan II engines used in modified form; principal changes are in upper altitude capabilities for the YLR-87-AJ-5 and the incorporation of a malfunction detection system; both liquid stages man-rated; first stage re-designed to start either on ground or in space and engine efficiency increased to accommodate various payloads; second stage operating time increased beyond Gemini range.

Titan III—Transtage

MANUFACTURER: Aerojet-General
PROPELLANTS: Storables—nitrogen tetroxide, Aerozene-50
START SYSTEM: Gas pressurized system
IGNITION: Hypergolic
THRUST: 16,000 lbs. total—8,000 lbs. from each of the twin barrels
REMARKS: Capable of start/stop operation in zero-g environment; engine has ablative chambers and titanium exhaust skirt; engine is slated to provide orbital changes for Titan III payloads; initial engine tests did not meet specified Isp; a Hernate system under Air Force evaluation

Titan III—Transtage Attitude Control System

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBERS: SE-9 (covers system of eight small engines for attitude control and ullage)
STATUS: Under development

Titan III-C—Boosters:

MANUFACTURER: United Technology Center
MANUFACTURER'S NUMBER: 1205
PROPELLANT: PBAN with aluminum additians and ammonium perchlarate
NOZZLE MATERIAL: Steel with plastic insulatian and graphite liner
LENGTH: 75 ft.
WIDTH: 10 ft.
IGNITION: Small solid rocket
THRUST: More than 1-million lbs. from each of two booster motors
BURNING TIME: Approx 110 sec.
STATUS: Midway through static test program
REMARKS: Each Titan III will carry two 1205 motors; UTC also is producing solid-propellant staging rockets for the booster motors; each booster will carry eight of the 4,500-lb.-thrust rockets—5 ft. long, 6 in. wide, aluminum

U.S. Research and Sounding Rockets

(Listed under system contractor: manufacturer's nomenclature, type, stoges and thrust, launch weight and overall length, performance, remarks, and using organizations.)

Aerolab Development Co.

ARGO A-2 (PERCHERON) Baosted single-stage solid research rocket, Thiokol Castar XM-33 with two Thiakol Recruit XM-19's (122,000-lb. totol thrust); weight, 10,000 lb.; length, 21 ft.; 500-lb. payload to altitude af 200 n. mi.; first stage Shotput; NASA

ARGO A-3 Single-stage solid research rocket, Hercules M-6 Honest John (86,000-lb. thrust); weight, 5,910 lb.; length, 21 ft.; 2,000-lb. payload to altitude of 10 n. mi.; used in Goodyear/USAF-ASD Ballute tests; AF

ARGO B-1 Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Cajun (9,600-lb. thrust); weight, 1,540 lb.; length, 23 ft.; 50-lb. payload to altitude of 100 n. mi.; NASA, AF

ARGO B-7 Two stage solid reseorch rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust); 2nd—Hercules M-5 Nike (48,700-lb. thrust); weight, 5,900 lb.; length, 31 ft.; 400-lb. payload to altitude of 40 n. mi.; used in Goodyeor/USAF-ASD Ballute tests; AF

ARGO B-8 Two-stage solid research rocket, 1st ond 2nd—Hercules M-5 Nike (48,700-lb. thrust each); weight, 28,000 lb.; length, 27 ft.; 400-lb. payload to altitude of 30 n. mi.; used in Goodyear/USAF-ASD Ballute tests; AF

ARGO B-9 Two-stage solid research rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Yardbird (17,100-lb. thrust); weight, 1,800 lb.; length, 24 ft.; 100-lb. payload to altitude of 130 n. mi.; under development; AF

ARGO B-11 Boosted twa-stoge solid research rocket, 1st—Thiokol Castor XM-33 w/two Thiokol Recruit XM-19's (122,000-lb. total thrust), 2nd—Hercules X-259 (21,350-lb. thrust); weight, 13,200 lb.; length, 34 ft.; 1,000-lb. payload ta altitude of 450 n. mi.; under development; NASA

ARGO B-13 Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol TE-307 (5,000-lb. thrust); weight, 1,600 lb.; length, 27 ft.; 60-lb. payload to altitude of 135 n. mi.; newly operational; NASA

ARGO B-21 Boosted two-stage solid research rocket, 1st—Thiokol Costor XM-33 w/two Thiokol Recruit XM-19's (122,000-lb. total thrust), 2nd—Thiokol TX-261 (57,000-lb. thrust); weight, 13,000 lb.; length, 42 ft.; 1,300-lb. payload to altitude of 250 n. mi.; under development (in-house)

ARGO B-23 Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—United Tech. Ctr. FW-3 (6,000-lb. thrust); weight, 2,160 lb., length, 22 ft.; 100-lb. payload to altitude of 360 n. mi.; under development; Novy

ARGO C-21 Boasted three-stage solid sounding rocket, 1st—Thiokol Castor XM-33 w/two Thiokol Recruit XM-19's (122,000-lb. totol thrust), 2nd—Hercules X-259 (21,350-lb. thrust), 3rd—United Tech. Ctr. FW-3 (6,000-lb. thrust); weight, 13,620 lb.; length, 50 ft.; 250-lb. payload to altitude of 1,250 n. mi.; Moch 19; under development; AF

ARGO C-22 Three-stage salid sounding rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd & 3rd—Hercules M-5 Nike (48,700-lb. thrust each); weight, 6,950 lb.; length, 43.6 ft.; 212-lb. payload to altitude of 120 n. mi.; Mach 6; uses swept-back stabilization fins; AF

ARGO C-23 Three-stoge solid sounding or research rocket, 1st—Thiokol XM-33 with two Thiokol TX-77's (147,000-lb. total thrust), 2nd—Thiokol TX-261 (57,000-lb. thrust), 3rd—Thiokol TX-306 (11KS13430); weight 14,300 lb.; length, 41.3 ft.; 150-lb. payload to altitude of 2,000 n. mi., Moch 21; in development for AF

ARGO D-4 (JAVELIN) Four-stage solid research rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd & 3rd—Hercules M-5 Nike (48,700-lb. thrust each), 4th—Hercules X-248 (3,000-lb. thrust); weight 7,400 lb.; length, 48.7 ft.; 100-lb. paylood to altitude of 550 n. mi.; NASA, AF

ARGO D-8 (JOURNEYMAN A) Four-stage solid research rocket; 1st—Thiokol XM-20 w/twa Thiakol 1.5KS3500 Recruits (121,000-lb. total thrust), 2nd & 3rd—Lockheed Lance (47,000-lb. thrust each), 4th—Hercules X-248 (3,000-lb. thrust); weight, 14,000 lb.; length, 62.0 ft.; 135-lb. payload ta altitude af 1,260 n. mi.; Moch 24; holds record for highest altitude (1,260 n. mi.) far recovered paylood; NASA

ARGO E-5 (JASON) Five-stage solid sounding rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd & 3rd—Hercules M-5 Nike (48,700-lb. thrust each), 4th—Thiakol TX-77 (46,000-lb. thrust), 5th—Thiokol T-55 (4,650-lb. thrust); weight 7,250 lb.; length, 56.5 ft.; 50-lb. payload ta altitude of 500 n. mi.; Mach 12.5; AF

TRAILBLAZER I Six-stage (incl. three downward-thrust packoged in reverse in 3rd stage) solid research rocket, 1st—Hercules M-6 Honest John (86,000-lb. thrust), 2nd—Hercules M-5 Nike (48,700-lb. thrust), 3rd—either Lockheed Lonce (47,000-lb. thrust) or Thiokol TX-77 (46,000-lb. thrust), 4th—Thiokol T-40, 5th—Thiokol T-55 (4,650-lb. thrust), 6th—NASA/Longley 5-in. spherical motor; weight, 7,500 lb.; length, 56 ft.; three stoges up to altitude of 200 n. mi., three stages down ottain 24,000 fps. (a "gun-fired" pellet fired downword has reached 35,000 fps.); NASA

American Machine and Faundry Co.

PURR KEE, ADVANCED Two-stage saunding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Hercules X-220 (6,400-lb. thrust); length, 6 ft.; in development for Navy

Atlantic Research Corp. (ARC)

ARCAS Single-stage solid sounding rocket, ARC 29KS-336; weight, 65 lbs.; length, 6.6-9.1 ft.; 12-lb. paylood to altitude of 40 mi.; all services and NASA

ARCAS, BOOSTED Two-stage solid sounding rocket, 1st—ARC IKS-2200, 2nd—ARC Arcas 29KS-336; weight, 100 lbs.; length, 10.5 ft.; 12-lb. payload to altitude of 50 mi.; all services, NASA, Conada, Sweden

ARCHER Single-stoge solid sounding rocket, ARC 35KS-1375; weight, 330 lbs.; length, 12.8 ft.; 40-lb. paylood to altitude of 90 mi.; all services and NASA

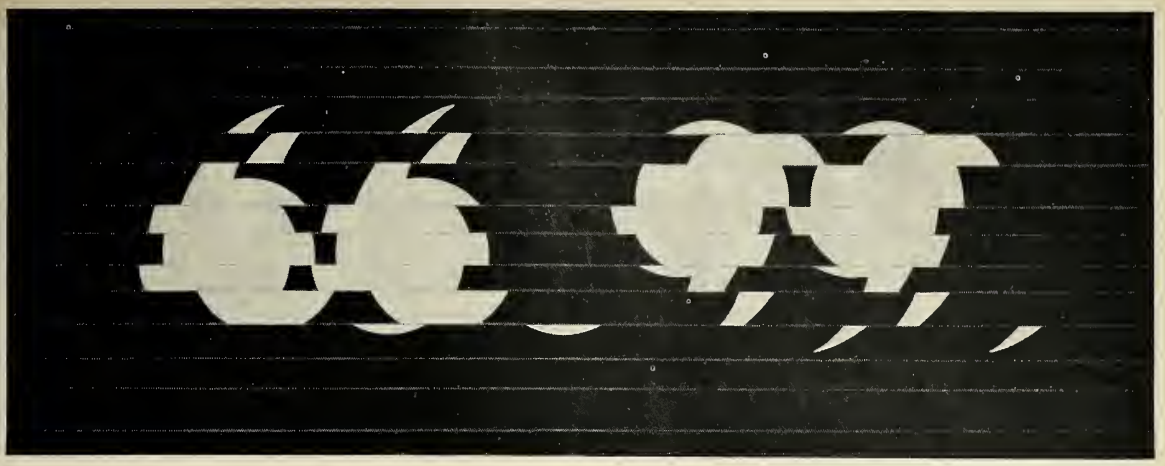
ATHENA Two, three-, or four-stage research rocket, 1st—Thiokol Costor XM-33 w/two Thiokol Recruit XM-19's (122,000 lb. tatol thrust), 2nd—either Hercules X-259 (19,000-lb. thrust) or Thiokol TX-261 (57,000-lb. thrust) depending on trojectory requirements, 3rd—Aerojet 30KS-8000, 4th—Hercules BE-3; weight, 16,000 lbs.; length, 50 ft.; 50 to 300-lb. payload to altitude of 200-500-mi.; four-stage version will employ two stages going up, fin stobilized, and two stoges down, with guidance in 3rd stoge; preselected ongle-of-attack control 0° ± 5°; flight distance 417 n. mi.; re-entry velocities from 16,000 to 23,000 fps; in development for advanced re-entry research and plosma-sheath studies (two-stoge version in flight-test stage, four-stoge version scheduled for flight test this summer); AF, ARPA.

HONEST JOHN-NIKE-NIKE Three-stoge solid sounding rocket, 1st—Hercules M6 Honest John (86,000-lb. thrust), 2nd and 3rd—Hercules M-5 Nike (48,700-lb. thrust); weight, 6,500 lbs., length 47 ft.; 250-lb. payload to oltitude of 135 mi.; Army, AF, NASA

HYDRA-IRIS Two-stage solid sounding rocket, 1st—three clustered Aerojet Sparrow 1.8-KS-7800's (22,400-lb. total thrust), 2nd—ARC 52KS-4375; weight, 1,350 lbs.; length 24 ft.; 100-lb. paylood to oltitude of 200 mi.; Navy

IRIS Single-stage solid sounding rocket, ARC 52KS-4375; weight, 1,350 lbs.; length, 24 ft.; 100-lb. paylood to altitude of 200 mi.; all services and NASA

METROC Single-stage salid sounding rocket, ARC 16KS-140; weight, 15 lbs.; length, 4.6 ft.; 2-lb. poyload to altitude of 20 mi.; all services and NASA



Multipath? Backscatter?



You can forget them with Martin Company's Adaptive RADA System

One key achievement of Martin Company's Adaptive RADA system: the elimination of multipath and backscatter effects which degrade system capacity, distort message transmission in most coded pulse systems.

The secret: a concept which combines the best features of exclusive, adaptive and co-channel signaling techniques. The result: a random access, discrete address system which provides highest subscriber capacity with maximum frequency conservation.

Here's how Martin's Adaptive RADA system works:

1. When one subscriber dials another, the signal is sent by a co-channel technique which activates the addressee's discrete address code.

2. When contact is established, Martin's adaptive RADA system automatically assigns the subscribers to a channel not in use.

3. Since Martin's adaptive RADA system selects only channels not in use, all other conversations are excluded from this channel—preventing degradation of voice quality due to multipath.

4. Once the conversation is completed, the channel is automatically freed for other subscribers' use.

Other features of Martin's Adaptive RADA system include:

1. CO-EXISTENCE WITH CONVENTIONAL UHF/VHF COMMUNICATIONS EQUIPMENT—since the adaptive system uses narrow channel signals, they can be more easily assigned to avoid interference with other users, and in case of conflict, the system will automatically "skip" the occupied channel.

2. AUTOMATIC POWER AND LEVEL CONTROL—automatically adjusts transmitter and receiver power to the optimum power necessary to complete the radio link. Thus the same adaptive channel may be used and re-used outside the call's transmission area.

3. AUTOMATIC SEQUENTIAL SEARCH—Martin's range extension transmitters automatically search out and locate any address—lets you dial any subscriber direct, whatever his location, without needing to know his "area code." Overlapping coverage of these range extension transmitters also provides alternate routing whether users are stationary or mobile—increases survivability and reliability of the system.

Martin's Adaptive RADA system has been tested and optimized by computer simulation, laboratory experiment and field testing.

It is another example of how Martin Company's new approach to old communications problems is producing better electronic systems for our country's defense.

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CAREER NEWS FROM HUGHES

Aerospace Divisions in Culver City, California

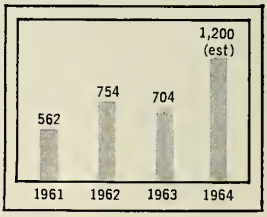
NEW AND CONTINUING PROGRAMS AND PROJECTS

F-111B PHOENIX Missile System
SURVEYOR Lunar Landing Vehicle
SYNCOM Synchronous Communications Satellite
POLARIS Guidance
TOW Anti-tank Missile
VATE Automatic Checkout System
FALCON Missiles
ARPAT
HARD POINT DEFENSE

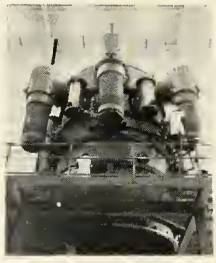
These examples of Hughes Aerospace activities are representative of *more than* 230 major product and service capabilities ranging from aerospace vehicles to ASW systems.

GROWTH OF THE ENGINEERING STAFF

Of the over 9,000 employees of these divisions, 3,000 are Members of the Technical Staff. Average length of experience is 11.0 years. Average age is 33 years.

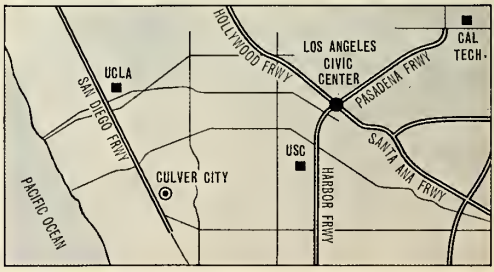


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This giant environmental test chamber at Hughes new Space Simulation Laboratory is just one of a complete range of facilities maintained by the company for the Technical Staff. Hughes physical plant and professional atmosphere, unexcelled in industry, encourage individual achievement.

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METROC, BOOSTED Two-stage solid sounding rocket, 1st—ARC Metrac 16KS-140, 2nd—2.75 FFAR (Navy rocket, 720-lb. thrust); weight, 26 lbs.; length, 8.8 ft.; 2-lb. payload to altitude of 52 mi.; all services and NASA

NIKE-APACHE Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Apache (5,900-lb. thrust); weight, 1,550 lbs.; length, 23 ft.; 50-lb. payload to altitude of 130 mi.; all services and NASA

NIKE-ARCHER Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—ARC Archer 35KS-1375; weight, 1,650 lbs.; length, 25 ft.; 40-lb. payload to altitude of 230 mi.; all services and NASA

NIKE-CAJUN Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Cajun (9,600-lb. thrust); weight, 1,550 lb.; length, 23 ft.; 50-lb. payload to altitude of 100 mi.; all services and NASA

SIDEWINDER-HV ARCAS Two-stage solid sounding rocket, 1st—Naval Propellant Plant Sidewinder 1A, 2nd—ARC high velocity Arcas 29KS-336; weight, 168 lbs.; length, 13.8 ft.; 12-lb. payload to altitude of 81 mi.; all services

SPARROW-HV ARCAS Two-stoge sounding rocket, 1st—Aerojet Sparraw I, 2nd—ARC high-velocity Arcas 29KS-336; weight, 206 lbs.; length, 13 ft.; 12-lb. payload to altitude of 100 mi.; all services

SWIK Two-stage salid research rocket, 1st—Thiokol Castor XM-33 (55,000-lb. thrust), 2nd—Hercules X-254 (14,100-lb. thrust); weight, 13,200 lbs.; length, 35 ft.; 300-lb. payload to altitude of 675 mi.; Army, AF

TRAILBLAZER II Faur-stage solid research rocket, 1st—Thiokol Castar XM-33 with twa Thiokol Recruit XM-19's, (122,000-lb. total thrust), 2nd—Lackheed Lance· (47,000-lb. thrust), 3rd—Hercules Altair X-248 (3,000-lb. thrust), 4th—ARC/NASA 15-in. spherical (5,000-lb. thrust); weight, 13,-344 lbs.; length, 50 ft.; two stages up, two stages downward to achieve re-entry velocity of 22,000 fps; NASA, Army, AF

Hercules Powder Co.

DEACON (POGO-HI) Single-stage Hercules X-220 solid motor (6,100-lb. thrust); weight, 155 lb.; length, 9.2 ft.; poyload weight vs. altitude varies with eoch program; Army, Navy, NASA, ARPA

Longley Research Center, NASA

METEOR SIMULATION VEHICLE (1) (Modified Trailblazer II); Six-stage solid research rocket; 1st—Thiakal Castar XM-33 w/twa Thiakal Recruit XM-19's (122,000-lb. tatal thrust), 2nd—Lockheed Lance (47,000-lb. thrust), 3rd—Hercules Altair X-248 (3,000-lb. thrust), 4th—NASA Cygnus-15 (3,200-lb.-thrust, 15-in.-dia. spherical), 5th—NASA Cygnus-5 (550-lb.-thrust, 5-in.-dia. spherical), 6th—Army Ballistics Research Lab. shaped-charge acceleratar and re-entry pellet; ARC spin-stabilized velacity package contains last faur stages; 13,500 lbs., 51.5 ft.; twa stages up to 300-km. altitude, remaining stages packaged in reverse ta achieve 20 km/sec. re-entry velacity, 15 deg. aff vertical at 75-km. altitude; NASA

METEOR SIMULATION VEHICLE (2) (Madified Nike-Cajun); Faur-stage salid research racket; 1st—Hercules Nike (53,000-lb.-thrust), 2nd—Thiakal Cajun (8,600-lb.-thrust), 3rd—NASA Cygnus-5 (550-lb.-thrust, 5-in.-dia. spherical), 4th—Army Ballistics Lab. shaped-charge acceleratar and re-entry pellet; Zimmey Carp. spin-stabilized velacity package which cantains twa sets af the 3rd and 4th stages maunted in reverse; 1,575-lbs., 27.5 ft.; twa stages up to 120-km. altitude, twa separate re-entries af different pellet materials each with 11 km/sec. re-entry velocity, 15 degrees aff vertical at 75-km. altitude; NASA

The Marquardt Carp.

ASP I Single-stage Marquardt 5.3KS-5800 solid motor; weight, 216.5 lbs.; length, 8.9 ft.; 50-lb. payload to altitude of 35 mi.; max. acceleratian 58 g; Navy

ASP IV Single-stage Marquardt 12.7KS-2750 solid motor; weight, 208 lbs.; length, 8.9 ft.; 50-lb. payload ta altitude af 50 mi.; max. acceleratian 20 g; Navy

ASPAN 150 Twa-stage solid sounding racket; 1st—Hercules M5 Nike (48,700-lb. thrust), 2nd—Marquardt Asp-1; weight, 1,503.0 lbs.; length, 21 ft.; 50-lb. payload ta altitude of 150 mi.; max. acceleration 53 g; AF (NASA alsa used vehicle but is phasing it out)

ASPAN 300 Twa-stage solid sounding rocket, 1st—Hercules M5 Nike (48,700-lb. thrust); 2nd—Marquardt Asp-IV; weight, 1,491.5 lbs.; length, 21 ft.; 50-lb. payload ta altitude of 200 mi.; max. acceleratian far 60-lb. payload 41 g; Navy

ROKSONDE 200 Single-stage Marquardt A-1 solid matar (2,000-lb. thrust); weight, 32.5 lbs.; length, 12 ft.; 10-lb. paylaad ta altitude af 200,000 ft. (chaff, parachute, ar instrumentatian); max. acceleration 120 g; AF, Army, NASA, and Italian government

ROKSONDE 250 Single-stage Marquardt A-1 solid motor (2,500-lb. thrust); weight, 32.5 lbs.; length, 12 ft.; 10-lb. paylaad ta altitude af 300,000 ft. (chaff, parachute, or instrumentatian); max. acceleratian 120 g; under campany development

Navy Missile Center, Paint Mugu, Calif.

SPAROAIR Air-launched two-stage research rocket far use on F38 ar F68 jet aircraft; Mach 0.8 at 32,000 ft., 1st and 2nd—Aerojet Sparraw III's; 35-lb. payload ta altitude af 65 n. mi.; used in Projects Tee Pee, Jane, and Night Owl for plasma generatian, infrared and ultraviolet re-search, respectively; Navy, Army, General Motars Carp.

Naval Ordnance Test Station (NOTS, China Lake)

HOVERING ROCKET SYSTEM Two-stage research rocket, 1st—Thiakal Pershing 2nd stage, 2nd—NOTS ta develap 19 x 3-ft.-dia. liquid engine (8,000-lb. thrust); weight, 700-lb.; length, 27 ft.; recaverable paylaad ta altitude af 65,000-500,000 ft.; 2nd stage carries cammand guidance, capable af stabilized 120-30 sec. hovering; two vehicles in develapment far upper-atmasphere research measurements and possibly surveillance use; Defense Atomic Support Agency

Racketdyne Div., North Americon Aviatian, Inc.

AEOLUS 1-90 Single-stage solid sounding rocket (315-lb. thrust); weight, 41 lbs.; length, 4.25 ft.; 6-lb. payload to altitude of 90,000 ft.; launched from 5-in. gun or reinforced plastic shipping contoiner; Navy

AEOLUS 1-200 Single-stage solid sounding rocket (500-lb. thrust); weight, 69.6 lbs.; length, 7.39 ft.; 6-8 lb. payload to altitude of 200,000 ft.; Navy

Rocket Power, Inc. (RPI)

HOPI CHAFF DART Single-stoge RPI 3.OKS-4000 Hopi-II solid motar; weight, 93 lbs.; length, 11 ft.; 11.5-lb. payload to altitude of 300,000 ft.; NASA

JUDI BALLOON DART Single-stage RPI 1.9KS-2100 Judi-I solid mator; weight, 33.7 lbs.; length, 9 ft.; 10-lb. paylaad (std AF Mylar Robin Sphere) ta 200,000 ft.; all services and foreign governments

JUDI CHAFF (OR PARACHUTE) DART Single-stage RPI 1.9KS-2100 Judi-I salid motor; weight, 30.3 lbs.; length, 8.6 ft.; 10-lb. paylaad to altitude of 240,000 ft.; all services, NASA and foreign governments

JUDI INSTRUMENTED DART Single-stage RPI 1.9KS-2100 Judi-I solid motar; weight, 33.7 lbs.; length, 9 ft.; 10-lb. payload to altitude af 220,-000 ft.; all services and foreign governments

KISHA-JUDI Two-stage solid sounding rocket; 1st—RPI 4.4KS-4800 Kisha-I, 2nd—RPI 1.9KS-2100 Judi-III; weight, 221 lbs.; length, 14 ft.; 16-lb. payload to altitude of 480,000 ft.; Sandia Corporation

ORIOLE Single-stage RPI 5.5KS-6100 Kiva-I solid matar; weight, 236 lbs.; length, 13.6 ft.; 10-lb. payload ta 473,000 ft. (Dart with 81.5 cu. in payload volume); all services

PHOENIX-I Twa-stage solid sounding rocket; 1st—RPI 5.5KS-6100 Kiva-I, 2nd—RPI 3.OKS-4000 Hopi-II; weight, 320 lbs.; length, 18 ft.; 10-lb. paylaad to altitude af 225 miles; all services

RAVEN Single-stage RPI 8.5KS-1800 solid motor; weight, 100 lbs.; length, 10.8 ft.; 10-lb. payload to altitude of 250,000 ft.; under develapment far meteoralagical use by all services and NASA

SIDEWINDER-RAVEN Two-stage solid saunding rocket; 1st—Naval Propellant Plant, Sidewinder 1A, 2nd—RPI 8.5KS-1800; weight, 208 lbs.; length, 17 ft.; 20-lb. paylaad to altitude of 400,000 ft.; all services

THUNDERBIRD Single-stage RPI 15KS-4800 solid motor; weight, 445 lbs.; length, 16 ft.; 35-lb. payload to altitude of 620,000 ft.; under development for Navy

Space-General Corp.

AEROBEE 100 Boosted single-stage sounding rocket; sustainer—liquid IRFNA & JP-4 engine (2,600-lb. thrust for 40 sec.), booster—Aerojet 2.5-KS-18,000 solid motor; weight, 1,470 lbs.; length, 25.75 ft.; 70-lb. payload to altitude of 80 mi.; tower launched; max. accelerotion 15.2 g; NASA, AF

AEROBEE 150 & 150A Boosted single-stage sounding rocket; sustainer—liquid IRFNA and aniline-furfuryl-alcohal mixture engine (4,100-lb. thrust for 51.8 sec.), baaster—Aerojet 2.5KS-18,000 solid motor; weight, (150), 1,943 lbs.; length, (150), 29.67 ft.; weight, (150A), 1,941 lbs.; length, (150A), 30 ft.; 150-lb. payload to altitude of 152 mi.; max. acceleration 10.3 g; tower launched; 150 version has 3 fins, 150A has 4 fins; altitude contral and recavery systems available in both vehicles; NASA, AF, Navy, Kitt Peak Observatory

AEROBEE 300 & 300A Two-stage sounding rocket; 1st—Aerobee 150 or 150A, 2nd—salid Aerojet Sparrow 1.8KS-7800; weight, 2,103 lbs.; length, (300), 33.00 ft., (300A), 33.30 ft.; 35-lb. payload to altitude of 300 mi.; max acceleration 63.8 g; 300A has 4 fins; NASA, AF

AEROBEE 350 Design goal 150-lb. payload to altitude of nearly 300 mi.; under development for NASA

ASTROBEE 200 Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Aerojet 30KS-8000; weight, 2,601 lbs.; length, 26.42 ft.; 150-lb. payload to altitude of 170 mi.; max. acceleration 18.9 g; boam-launched; NASA, AF

ASTROBEE 250 Single-stage solid sounding rocket; Aerojet 28KS-57,000, aptianal auxiliaries—two Thiokol 1.5KS-35,000; weight, 10,358 lbs.; length, 34.17 ft.; 400-1,000-lb. payload to altitudes between 190-120 mi.; max. acceleration 13 g; boom launched; NASA, AF, Navy

ASTROBEE 1500 Two-stage solid sounding rocket, 1st—Aerojet 28KS-57,000 with two Thiokol 1.5KS-35,000, 2nd—Aerojet 30KS-8000; weight, 11,493 lbs.; length, 34.17 ft.; 130-lb. payload to altitude of 1,300 mi.; max. acceleration 37 g; boom-launched; under development for NASA, AF, Sandia (replacement for NASA Journeymen A)

Thiokol Chemical Corp., Astra-Met Div.

ADVANCED TERRIER-TOMAHAWK Two-stage solid sounding rocket, 1st—Hercules BT-3 Advanced Terrier (17,000-lb. thrust), 2nd—Thiokol TE-416 Tomahawk (11,000-lb. thrust); weight, 2,820 lbs.; length, 29.8 ft.; 200-lb. (12-in.-dia.) payload to altitude of 185 mi. or 75-lb. (9-in. dia.) payload to altitude af 350 mi.; all services and NASA

NIKE-APACHE Two-stage solid sounding rocket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol Apache (5,900-lb. thrust), weight, 1,-950 lbs.; length, 23 ft.; 50-lb. payload to altitude of 130 mi.; all services and NASA

NIKE-TOMAHAWK Two-stage solid sounding racket, 1st—Hercules M-5 Nike (48,700-lb. thrust), 2nd—Thiokol TE-416 Tomahawk (11,000-lb. thrust); weight 2,000 lbs.; length, 29.16 ft.; 125-lb. payload to altitude of 200 mi.; all services and NASA

TOMAHAWK Single-stage solid sounding racket, Thiokol TE-416 Tomahawk (11,000-lb. thrust); weight, 585 lbs.; length, 16.5 ft.; 50-lb. payload to altitude of 105 mi.; all services and NASA

Satellites in Orbit

EXPLORER 1 (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits Earth; perigee 341 km, apogee 1,605 km, period 104.6 min.; not transmitting.

VANGUARD I (3.25 lbs.) U.S. Launched 3/17/58, est. life 200 years. Orbits Earth; perigee 630 km, apogee 3,958 km, period 134.0; transmitting 108.012 mc

LUNIK I "MECHTA" (3245 lbs.) USSR. Launched 1/2/59. In orbit around Sun on 450-day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

VANGUARD II (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits Earth; perigee 558 km, apogee 3,283 km, period 125.4; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun an 398-day cycle; aphelion 1.142 au, perihelion 0.9871 au; not transmitting.

VANGUARD III (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits Earth; perigee 511 km, apogee 3,717 km, period 129.8; not transmitting.

EXPLORER VII (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits Earth; perigee 551 km, apogee 1,074 km, period 101.2; not transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun on 312-doy period; aphelion 0.995 au, perihelion 0.8061 au, not transmitting.

TIROS I (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits Earth; perigee 700 km, apogee 739 km, period 99.2; not transmitting.

TRANSIT IB (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits Earth; perigee 347 km, apogee 588 km, period 93.9. Not transmitting.

MIDAS II (5,000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits Earth; perigee 473 km, apogee 493 km, period 94.3. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits Earth, perigee 610 km, apogee 1,062 km, period 101.6. Not transmitting.

NRL SOLAR RADIATION SATELLITE I (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits Earth; perigee 610 km, apogee 1,059 km, period 101.6. Not transmitting.

ECHO I (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits Earth; perigee 999 km, apogee 1,851 km, period 114.4.

COURIER IB (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits Earth; perigee 963 km, apogee 1,212 km, period 107.0. Not transmitting.

EXPLORER VIII (90 lbs.) U.S. Lauched 11/3/60 by JUNO II, est. life 20-50 years. Orbits Earth; perigee 417 km, apogee 2,249 km, period 112.3. Not transmitting.

TIROS II (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits Earth; perigee 613 km, apogee 735 km, period 98.2. Not transmitting.

SAMOS II (4,100 lbs.) U.S. Launched 1/31/61. Orbits Earth; perigee 469 km, apogee 544 km, period 94.7.

VENUS PROBE (1,419 lbs.) U.S.S.R. Launched 2/12/61. Orbits Sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

EXPLORER IX (15 lbs.) U.S. Launched 2/16/61. Orbits Earth; perigee 502 km, apogee 2,560 km, period 116.5.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Position uncertain.

EXPLORER XI (82 lbs.) U.S. Launched 4/27/61. Orbits Earth; perigee 477 km, apogee 1,783 km, period 108.0. Measures stellar gamma rays absorbed in Earth's atmosphere.

TRANSIT IVA (IVA, 175 lbs.; GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits Earth; TRANSIT—perigee 877 km, apogee 1,002 km, period 103.8. Transmitting 150.400 mc. GREB-INJUN—perigee 877 km, apogee 1,003 km, period 103.8. Not transmitting. IVA: 54; 150; 324; 400. GREB-INJUN: Not transmitting. GREB III and INJUN failed to separate.

TIROS III (285 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 732 km, apogee 823 km, period 100.4.

MIDAS III (3,500 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 3,381 km, apogee 3,510 km, period 161.5.

EXPLORER XII (83 lbs.) U.S. Launched 8/16/61. Insufficient observations.

MIDAS IV (3,500 lbs.) U.S. Launched 10/21/61. Orbits Earth; perigee 3,523 km, apagee 3,730 km, period 166.0.

TRANSIT IVB (200 lbs.) U.S. Launched 11/15/61. Orbits Earth; perigee



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948 km, apogee 1,111 km, period 105.8. Damaged by radiation from U.S. July 9, 1962, nuclear test.

TRAAC (240 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits Earth; perigee 960 km, apogee 1,101 km, period 105.8 Damaged by radiation from U.S. July 9, 1962, nuclear test.

RANGER III (727 lbs.) U.S. Launched 1/26/62. Orbits Sun on 406.4-day cycle; lunar probe failed to impact, went into heliocentric orbit; aphelion 1.163 au, perihelion 0.98339 au. Not transmitting.

TIROS IV (285 lbs.) U.S. Launched 2/8/62. Orbits Earth; perigee 702 km, apogee 849 km, period 100.4. Not transmitting.

ORBITING SOLAR OBSERVATORY (440 lbs.) U.S. Launched 3/7/62. Orbits Earth; perigee 553 km, apogee 582 km, period 96.0. Not transmitting.

COSMOS 2 (wt. unknown) USSR. Launched 4/6/62. Orbits Earth; perigee 183 km, apogee 549 km, period 91.8. Transmission data not known.

UK-1: International Satellite (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 392 km, apogee 1,177 km, period 100.5 Damaged by radiation from U.S. July 9, 1962, nuclear test. Transmitting 136.406 mc.

TIROS V (285 lbs.) U.S. Launched 6/19/62. Orbits Earth; perigee 598 km, apogee 964 km, period 100.5. Not transmitting.

TELSTAR I (170 lbs.) U.S. Launched 7/10/62. Orbits Earth; perigee 944 km, apogee 5,643 km, period 157.8. Not transmitting.

COSMOS 8 (wt. unknown) USSR. Launched 8/18/62. Orbits Earth; perigee 215 km, apogee 345 km, period 90.0.

MARINER II (447 lbs.) U.S. Launched 8/27/62. Heliocentric orbit on 348-day cycle. Planetary spacecraft came within 21,594 mi. of Venus Dec. 14, 1963. Perihelion 0.7046 au; aphelion 1.229 au.

TIROS VI (281 lbs) U.S. Launched 9/18/62. Orbits Earth; perigee 683 km, apogee 713 km, period 98.7. Not transmitting.

ALOUETTE (300 lbs.) Canada. Launched 9/29/62. Orbits Earth; perigee 999 km, apogee 1,037 km, period 105.5. Satellite built by Canada; launched by U.S. Transmitting 136.978; 136.591; 136.077 mc.

EXPLORER XIV (89 lbs.) U.S. Launched 10/2/62. Current elements not maintained. Not transmitting.

RANGER V U.S. Launched 10/18/62. Orbits Sun; perihelion 0.9498 au, aphelion 1.0681 au; period 370 days.

EXPLORER XV (98 lbs.) U.S. Launched 10/27/62. Orbits Earth; perigee 307 km, apogee 17,438 km, period 312.5 min. Transmitting 136.101 mc.

ANNA IB (350 lbs.) U.S. Launched 10/31/62. Orbits Earth; perigee 1,063 km, apogee 1,063 km, period 107.8. Not transmitting.

MARS I (1,965 lbs.) USSR. Launched 11/2/62. Was expected to come within 621-6,831 miles of Mars on June 25, 1963, but has ceased transmitting.

INJUN 3 (40 lbs.) U.S. Launched 12/13/62. Orbits Earth; perigee 239 km, apogee 2,490 km, period 113.0. Not transmitting.

RELAY I (172 lbs.) U.S. Launched 12/13/62. Orbits Earth; perigee 1,317 km, apogee 7,444 km, period 185. Transmitting 136.140; 136.620 mc.

EXPLORER XVI (222 lbs.) U.S. Launched 12/16/62. Orbits Earth; perigee 741 km, apogee 1,188 km, period 104.4. Not transmitting.

TRANSIT 5A (135 lbs.) U.S. Launched 12/19/62. Orbits Earth; perigee 702 km, apogee 730 km, period 99.1.

SYNCOM (86 lbs.) U.S. Launched 2/14/63. Orbits Earth. Current elements not maintained. Not transmitting, communications lost when satellite went into orbit.

LUNIK IV (3,135 lbs.) USSR. Launched 4/2/63. Position uncertain.

EXPLORER XVII (405 lbs.) USSR. Launched 4/3/63. Orbits Earth; perigee 250 km, apogee 799 km, period 95.1. Not transmitting.

COSMOS 14 (wt. unknown) USSR. Launched 4/13/63. Orbits Earth; perigee 245 km, apogee 383 km, period 90.7.

COSMOS 17 (wt. unknown) USSR. Launched 4/22/63. Orbits Earth; perigee 216 km, apogee 753 km, period 94.7.

TELSTAR II (175 lbs.) U.S. Launched 5/7/63. Orbits Earth; perigee 965 km, apogee 10,807 km, period 225.3. Transmitting 136.050 mc.

LOFTI IIA and SOLAR RADIATION SATELLITE (58 lb. each) U.S. Launched together 6/15/63. Orbit Earth; LOFTI's perigee 183 km, apogee 723 km, period 93.7. Transmitting 136.380 mc. Solar Radiation Satellite's perigee 177 km, apogee 806 km, period 94.1. Transmitting 136.890 mc.

TIROS VII (297 lbs.) U.S. Launched 6/19/63. Orbits Earth; perigee 618 km, apogee 654 km, period 97.4. Transmitting 136.233, 136.921 mc.

RESEARCH SATELLITE FOR GEOPHYSICS (wt. unknown) U.S. Launched 6/28/63. Orbits Earth; perigee 414 km, apogee 1,299 km, period 102.1. Not transmitting.

SYNCOM II (86 lbs.) U.S. Launched 7/26/63. Orbits Earth; perigee 35,796 km, apogee 35,903 km, period 1,493. Transmitting 136.980, 136.468, 1814.069, 1,815.794, 1,820.177 mc.

POLYOT I (wt. unknown) USSR. Launched 11/1/63. Orbits Earth; perigee 339 km, apogee 1,404 km, period 102.4. Transmission data not known.

EXPLORER XVIII (138 lbs.) U.S. Launched 11/27/63. Orbits Earth; perigee 1,911 km, apogee 194,068 km, period 5,592.391. Transmitting 136.112 mc.

CENTAUR II (10,700 lbs.) U.S. Launched 11/27/63. Orbits Earth; perigee 464 km, apogee 1,785 km, period 107.8. Not transmitting.

EXPLORER XIX (15 lbs.) U.S. Launched 12/19/63. Orbits Earth; perigee 602 km, apogee 2,366 km, period 115.6. Not transmitting.

TIROS VIII (265 lbs.) U.S. Launched 12/21/63. Orbits Earth; perigee 712 km, apogee 745 km, period 99.4. Transmitting 136.233, 136.924 mc.

GRAVITY-GRADIENT STABILIZATION EXPERIMENT (wt. unknown) U.S. Launched 1/11/64. Orbits Earth; perigee 891 km, apogee 954 km, period 103.5. Not transmitting.

EXTRA-GALACTIC RADIATION SATELLITE (wt. unknown) U.S. Launched 1/11/64. Orbits Earth; perigee 911 km, apogee 934 km, period 103.4 Transmitting 136.805.

SOLAR RADIATION SATELLITE (wt. unknown) U.S. Launched 1/11/64. Orbits Earth; perigee 911 km, apogee 934 km, period 103.5. Transmitting 136.887 mc.

RELAY II (172 lbs.) U.S. Launched 1/21/64. Orbits Earth; perigee 2,077 km, apogee 7,422 km, period 194.7. Transmitting 136.141, 136.621 mc.

ECHO II (547 lbs.) U.S. Launched 1/25/64. Orbits Earth; perigee 1,000 km, apogee 1,337 km, period 108.7. Transmitting 136.020, 136.170 mc.

SATURN V (37,700 lbs.) U.S. Launched 1/29/64. Orbits Earth; perigee 262 km, apogee 701 km, period 94.3. Not transmitting.

ELEKTRON I (wt. unknown) USSR. Launched 1/30/64. Orbits Earth; perigee 402 km, apogee 7,119 km, period 169.3. Transmission data not known.

ELEKTRON II (wt. unknown) USSR. Launched 1/30/64. Orbits Earth; perigee 584 km, apogee 67,838 km, period 1,356.3. Transmission data not known.

COSMOS 25 (wt. unknown) USSR. Launched 2/27/64. Orbits Earth; perigee 255 km, apogee 436 km, period 91.5. Transmission data not known.

COSMOS 26 (wt. unknown) USSR. Launched 3/18/64. Orbits Earth; perigee 254 km, apogee 329 km, period 90.4. Transmission data not known.

UK-2 (150 lbs.) U.S.-U.K. Launched 3/27/64. Orbits Earth; perigee 299 km, apogee 1,328 km, period 101.2. Transmitting 136.447 mc.

POLYOT II (wt. unknown) USSR Launched 4/12/64. Orbits Earth; perigee 307 km, apogee 468 km, period 92.3 Transmission data not known.

COSMOS 31 (wt. unknown) USSR. Launched 6/6/64. Orbits Earth; perigee 222 km, apogee 477 km, period 91.6. Transmission data not known.

COSMOS 33 (wt. unknown) USSR. Launched 6/23/64. Orbits Earth; perigee 212 km, apogee 306 km, period 89.48. Transmission data not known.

ELEKTRON 3 (wt. unknown) USSR. Launched 7/11/64. Orbits Earth; perigee 404 km, apogee 7,000 km, period 168. Transmission data not known.

ELEKTRON 4 (wt. unknown) USSR. Launched 7/11/64. Orbits Earth; perigee 456 km, apogee 65,800 km, period 1,314. Transmission data not known.



ALFA

MISSILES

surface to surface

Alfa (RUR-4) (Navy)

TYPE: Antisubmarine rocket-boosted depth charge

STATUS: Operotional

PRIME CONTRACTOR: Navy

FRAME CONTRACTOR: Avco

FRAME CONFIGURATION: Length, 8.5 ft.; diometer, 12.75 in.; weight, 500 lbs.

PROPULSION CONTRACTOR: Naval Propellant Plant

PROPULSION TYPE: Solid rocket

GUIDANCE CONTRACTOR: None

GUIDANCE TYPE: Free-flight

PAYLOAD: High-explosive depth charge

REMARKS: Operational aboord cruisers & destrayers since 1952; launched from turret-mounted guns to a maximum of 1,000 yds.

Asroc (RUR-5A) (Navy)

TYPE: Antisubmorine rocket-boosted torpeda

STATUS: Operotionol on escort ships, destroyers & cruisers

PRIME CONTRACTOR: Honeywell

FRAME CONTRACTOR: Honeywell/General Mills

FRAME CONFIGURATION: Length, 15 ft.; torpedo-worheod length, 100 in.; diameter, 12 in.; spon, 2.5 ft.; weight 1,000 lbs.

PROPULSION CONTRACTOR: Naval Prapellant Plant

PROPULSION TYPE: Solid rocket

GUIDANCE CONTRACTOR: Sangamo Electric

GUIDANCE TYPE: Sonar detection in torpedo nose; type SQS-23; unguided during aerial flight

PAYLOAD: General Electric Mk 44 homing torpedo with nucleor worhead or conventionol depth chorge

EQUIPMENT CONTRACTORS: Librascope-Generol Precision, digitol computer for fire control; Universol Match Co., louncher

PERFORMANCE: Range between 1,800 yds. and 8 n. mi.; speed about Moch 1

REMARKS: Initially operotionol in 1960; reploces Hedgehogs on surface ships; one "live" warhead fired during Pocific nuclear tests; advanced version under development; may be delayed because of limited ronges of ASW detection equipment

Astor (Navy)

TYPE: Rocket-baasted antisubmarine tarpedo

STATUS: Praductian

PRIME CONTRACTOR: Westinghause

FRAME CONTRACTOR: Westinghause

FRAME CONFIGURATION: Length, less baaster, 20 ft.; weight, over 2,000 lbs.

PROPULSION TYPE: Salid propellant

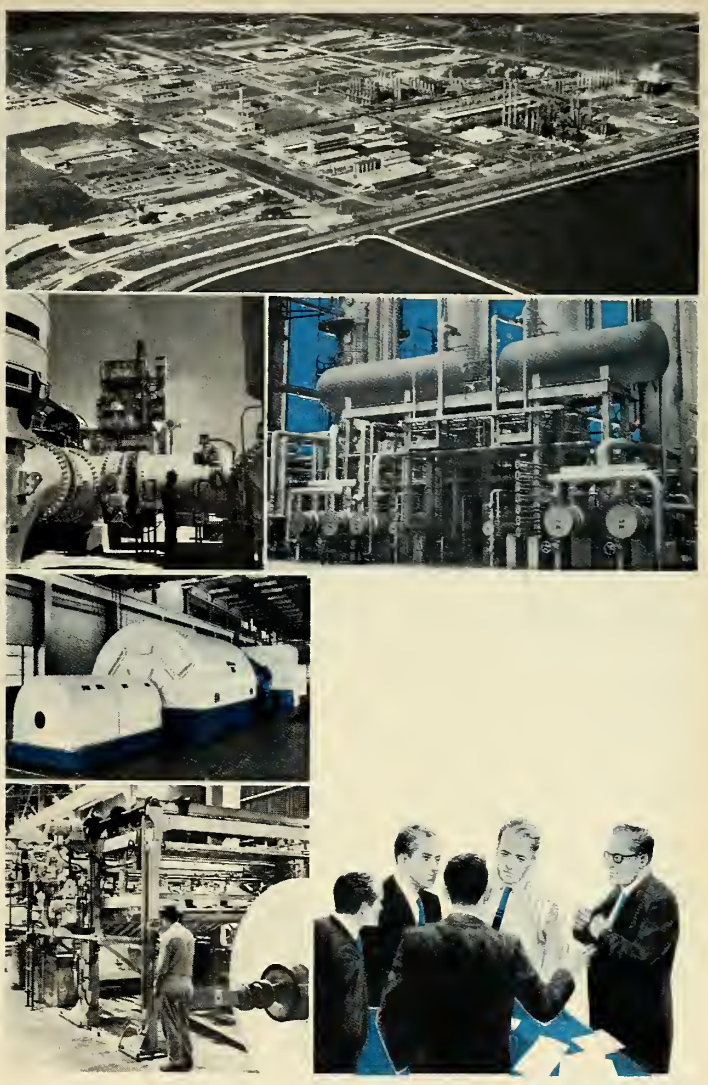
GUIDANCE TYPE: Wire-guided

PAYLOAD: Nuclear warhead an Mk 45 torpedo

PERFORMANCE: Range, abaut 11 n. mi.

REMARKS: Ta be deplayed abaard hunter-killer subs

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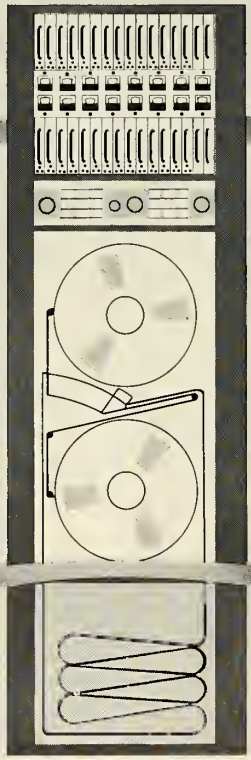
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ES64-3

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Atlas (CGM-16D, E), (HGM-16F) (Air Force)

TYPE: ICBM

STATUS: Operotionol

PRIME CONTRACTOR: TRW STL, systems engineering & technical direction

FRAME CONTRACTOR: Generol Dynomics/Astronautics

FRAME TYPE & CONFIGURATION: Stoinless-steel pressurized tonkage; length, 82.5 ft.; tankage diometer, 10 ft.; bose diameter, 16 ft.; lounch weight, 269,000 lbs.

PROPULSION CONTRACTOR: Rocketdyne

PROPULSION TYPE: Two liquid-propellant booster engines & one sustoiner; boosters produce 165,000 lbs. thrust eoch ond sustoiner produces 60,000 lbs.; uses LOX & RP-1 propellonts

GUIDANCE CONTRACTOR: GE/Burroughs for Series D; American Bosch Armo for Series E and F

GUIDANCE TYPE: Rodio-inertial for Series D (first four squodrons) and all-inertial for remoining nine squadrons

PAYLOAD: Nucleor worheod; reentry vehicles by GE ond Avco

GROUND EQUIPMENT CONTRACTORS: General Dynomics, lounch focilities integration; prapellant looding system, Arthur D. Little Ca.; propellont utilization system, Acoustica Associotes

PERFORMANCE: Ronge, 9,000 miles; speed, over 16,000 mph

REMARKS: 13 squodrons operotionol ot 11 boses with totol of 129 missiles; phoseout of Atlos D to be completed in FY '65; E's sometime loter; used os spoce lounch vehicle for o wide voriety of progroms; Atlos D used to boast ASSET spacecroft ond booster for other spoce progroms.

Close-Support Assault Weapon (Navy)

TYPE: Ship-to-shore

MISSION: Close support of omphibiaus londings

PRIME CONTRACTOR: Novy Bureou of Weapons ond Johns Hopkins University Applied Physics Lab

CONFIGURATION: Outside dimensions of the missile are to be compotible with Terrier shipboord installotions

PROPULSION: Solid

GUIDANCE CONTRACTOR: Norden Div., United Aircroft

GUIDANCE: Inertiol with a single-degree-of-freedom gyro; terminal guidance

PERFORMANCE: Ronge of ot least 30 miles

PAYLOAD: High explosive worhead

REMARKS: System is being carried os o line item in the FY '66 budget; however, funding is to some degree dependent on results of guidonce system flight tests ot WSMR oboord Sergeont missiles; extreme occurocy is a requirement, hence terminol guidonce system, which outomoticolly acquires the missile ond brings it into the torget

Davy Crockett (Army)

TYPE: Surfoce-to-surfoce tactical nucleor support weapon

STATUS: Operotionol

PRIME CONTRACTOR: In-house, Army Weopons Command

FRAME TYPE & CONFIGURATION: Bulbous, 279-mm super caliber projectile fired from either 120-mm or 155-mm recoilless rifle through odopter pistons

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Free-flight

PAYLOAD: Sub-kiloton nuclear warheod

PERFORMANCE: Classified

REMARKS: Deployed in Europe; $13 million provided in FY '64 budget; 20 weapons per division; all mentian of weopon being issued to troops is missing from FY '65 force structure discussions



ATLAS

ENTAC (MGM-32A) (Army)

TYPE: Antitank missile
STATUS: Operational
PRIME CONTRACTOR: Nord Aviation
FRAME CONFIGURATION: Length, 32 in.; diameter, 5.5 in.; weight, 37 lbs. with launcher, 27 lbs. without launcher
PROPULSION TYPE: Solid
GUIDANCE TYPE: Wire-guided
PAYLOAD: High-explosive shaped chorge
PERFORMANCE: 6,600-ft. range; speed abaut 180 mph
REMARKS: Pracurement complete; will be replaced by TOW

Honest John (MGR-1) (Army)

TYPE: Surface-ta-surface rocket
STATUS: Operational
PRIME CONTRACTOR: Douglas
FRAME CONTRACTOR: Douglas/ Emersan Electric
FRAME TYPE & CONFIGURATION: Length, 24.8 ft.; diameter, 30 in.; weight, 4,500 lbs.
POPULSION CONTRACTOR: Hercules, moin; Thiokol, spin rockets
PROPULSION TYPE: Single-stage salid propellant
GUIDANCE TYPE: Free-flight, spin-stabilized
PAYLOAD: Nuclear ar high-explosive warhead
PERFORMANCE: Range, 12 mi.; speed, Mach 1.7
REMARKS: FY '65 buy of missile completes Army inventary requirement; to be reploced by Lonce; being used by NATO

Lance (XMGM-52) (Army)

TYPE: Surface-to-surface Division support missile
STATUS: Engineering development
PRIME CONTRACTOR: LTV Michigan Div.
PROPULSION CONTRACTOR: Racketdyne
PROPULSION TYPE: Prepackaged storoble liquid rocket
GUIDANCE CONTRACTOR: Systron-Donner
GUIDANCE TYPE: Simplified inertial (Automet)
PAYLOAD: Primarily an improved (bomblet) HE warhead; nuclear worhead can be used againsf hard targets; also has chemical copability
PERFORMANCE: Range between 3 and 30 miles; very lightweight system with great mobility
REMARKS: Will replace Lacrosse and Honest John ond perhops Little John; initiol procurement of missiles and ground equipment far training in FY '65; air- and helicopter-transportoble

LASV (Air Force)

TYPE: Surface-to-surface low-altitude supersonic vehicle
STATUS: Powerplant and component development recently concelled by DOD
PRIME CONTRACTOR: Ling-Temco-Vought
PROPULSION CONTRACTOR: Atamics International/Lawrence Rodiation Lobaratory, reactar; Morquardt, overoll propulsion; Lockheed, studies of chemicol-fueled version
PROPULSION TYPE: Primorily o nucleor-powered, air-breathing ramjet developed under the Pluto program; feasibility proven by Tory reactor tests; sharter range chemical version being studied
GUIDANCE TYPE: Probably all-inertial, with terrain-avoidance radar feature
PAYLOAD: Nuclear warhead
PERFORMANCE: Ronge, unlimited; speed, over Mach 3
REMARKS: DOD decided nat to support a $200-500 million flight-test pragram in July, 1964; Chemicol Low Altitude Missile (CLAM) being considered os port of seo-bosed deterrent study

HONEST JOHN



Little John (MGR-3A) (Army)

TYPE: Suppart af airbarne aperatians

STATUS: Operatianal

PRIME CONTRACTOR: Emersan Electric Co./Consalidated Western Steel

FRAME TYPE & CONFIGURATION: Steel & aluminum; length, 14.5 ft.; diameter, 12.4 in.; weight, 800 lbs.

PROPULSION CONTRACTOR: Hercules

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Free-flight

PAYLOAD: Nuclear ar high-explosive warhead

PERFORMANCE: Range, aver 10 mi.; speed, supersanic

REMARKS: Supplements medium and heavy artillery in airbarne divisians and air-transpartable cammands; two battalians activated in 1961, each with four launchers; ta be replaced by Lance

M72 Rocket Grenade (Army)

TYPE: Antitank

STATUS: Operotional

PRIME CONTRACTOR: Hesse-Eastern Div., Flightex Fabrics, Inc.

FRAME TYPE & CONFIGURATION: Length, 25 in.; diameter, 3 in.; weight, 4.5 lbs.

PROPULSION TYPE: Solid propellant, which burns aut before racket leaves launch tube

GUIDANCE TYPE: Free-flight, finstobilized

PAYLOAD: "Octol" high-explosive warhead

PERFORMANCE: Range, 500 yds.

REMARKS: Carrying tube serves as disposable launcher; replaces rifle grenades and 3.5-in. racket launcher; farmerly called LAW (light antitank weapan); useful against tanks, pillboxes and ather hard-paint targets

Mace (MGM-13A) (CGM-13B) (Air Force)

TYPE: Air-breathing

STATUS: Operatianal

PRIME CONTRACTOR: Martin

FRAME TYPE & CONFIGURATION: Pilotless aircraft type; length, 44 ft.; wingspan, 22.5 ft.; height, 9.5 ft.; weight, A, 14,000 lbs.; B, 18,000 lbs.

PROPULSION CONTRACTOR: Thiokol/Allisan

PROPULSION TYPE: Solid booster rocket/J-33 turbojet

GUIDANCE CONTRACTOR: Goadyear/AC Spark Plug

GUIDANCE TYPE: A, ATRAN, automatic terroin radar and novigotor; B, inertial worhead

PERFORMANCE: Range: A, over 650 n. mi.; B, over 1,200 n. mi.; speed, over 650 mph; ceiling, aver 40,000 ft.

REMARKS: A substantially improved version of Matador, which it reploced; A&B deplayed in Europe and B deployed on Okinowa; A fired from mobile launcher; B fram a hardened "coffin"-type pad

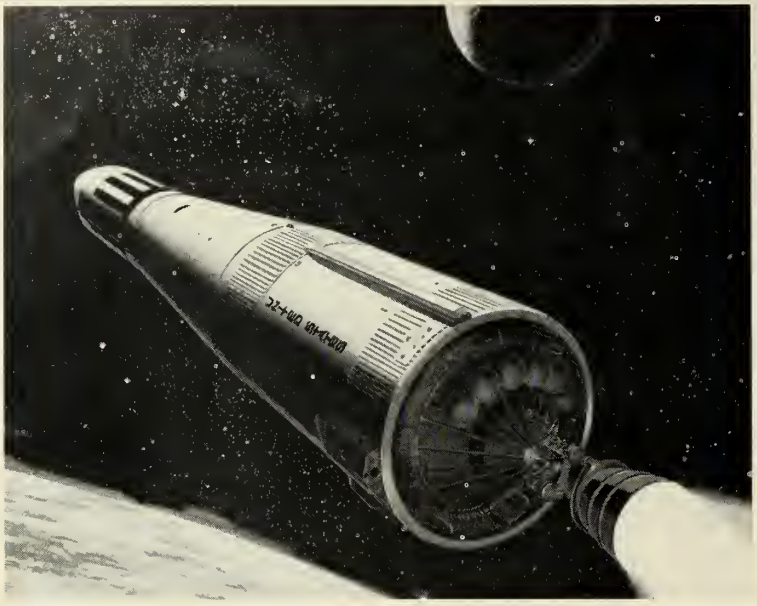
LITTLE JOHN



MACE



LOOK WHAT DOUGLAS IS DOING NOW!

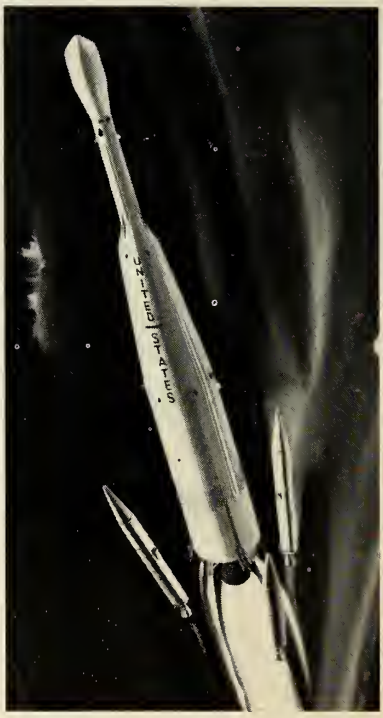


TO HELP PUT MAN ON THE MOON, *Saturn* S-IVB is being built by Douglas under direction of NASA's Marshall Space Flight Center. S-IVB is 58 feet tall and 22 feet in diameter. As upper stage of *Saturn*, it will provide the thrust that will send 3 *Apollo* astronauts from earth orbit to moon orbit.

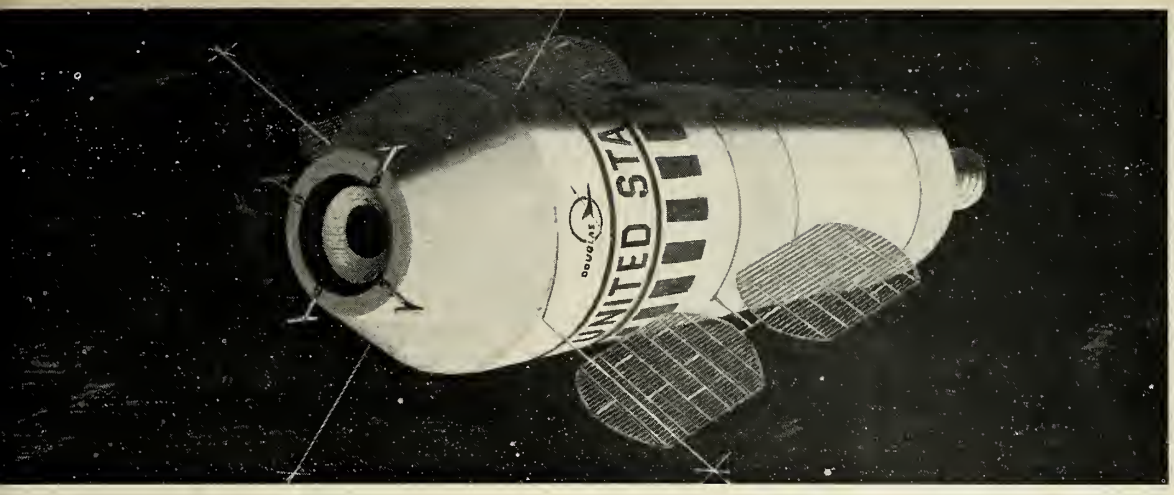


PACKAGING THE EARTH'S ENVIRONMENT for delivery anywhere in the solar system is the aim of Douglas biotechnology research. Means are being developed to provide spacemen with every factor they require to allow them to survive and perform efficiently during protracted space missions.

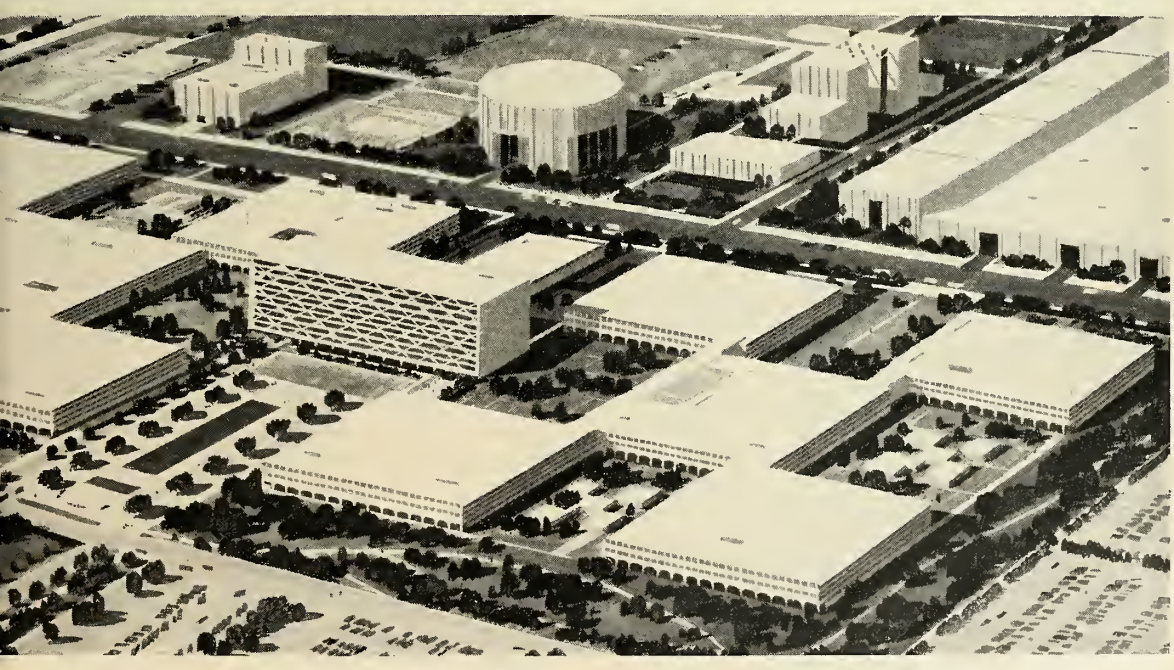




MORE BOOST FOR DELTA, world's most reliable space vehicle, is being achieved for the National Aeronautics and Space Administration by utilizing the Air Force/Douglas Improved THOR as first stage. Douglas is developing the thrust-augmented *Delta* (TAD) for NASA's Goddard Space Flight Center. NASA will continue use of the standard Douglas *Delta*.



O STUDY SPACE FROM UP THERE, NASA has ssigned studies of advanced planning for a six man orbiting pace laboratory to Douglas. It could be boosted into orbit y *Saturn* sometime in the '70s. Crewmen, supplies and equipment would be ferried to and from it in *Gemini* capsules. Advantages to be gained from the space laboratory are enormous in such varied fields as weather prediction, medicine, bacteriology, astronomy and many others.



HE NEW DOUGLAS SPACE SYSTEMS CENTER n Huntington Beach, California, is one of the world's finest rivately-owned space complexes. Here, talented engineers, cientists and technicians of the company's Missile & Space ystems Division are supported by advanced facilities as they research, test and build systems and vehicles that will help maintain U.S. leadership in space exploration. The new Douglas Center is designed for continued growth. Its capacity will be enlarged to meet the requirements of even more formidable space challenges of the future.

IN THE AIR OR OUTER SPACE...

DOUGLAS GETS THINGS DONE!



MINUTEMAN

Matador (MGM-1C) (Air Force)

TYPE: Air-breathing

STATUS: Operotionol, phosed out of U.S. forces ond turned over to ollies

PRIME CONTRACTOR: Mortin

FRAME TYPE & CONFIGURATION: Pilotless oircroft type; length, 39.6 ft.; height, 9.67 ft.; wingspon, 27.B ft.; weight, 10,000 lbs.

PROPULSION CONTRACTOR: Thiokol/Allison

PROPULSION TYPE: Solid rocket booster/J-33 turbojet

GUIDANCE CONTRACTOR: Air Force

GUIDANCE TYPE: Duol system including MSQ rodor line-of-sight control ond "Shonicle," o form of LORAN, using hyperbolic grid system

PAYLOAD: Nucleor worheod, mointoined under U.S. control

PERFORMANCE: Ronge, over 600 n. mi.; speed, over 650 mph.; ceiling, over 35,000 ft.

REMARKS: West Germony ond Notionolist Chinese using the system

Minuteman (LGM-30A, B, F) (Air Force)

TYPE: ICBM

STATUS: A & B operotionol; F, operotionol system development

SYSTEMS CONTRACTOR: TRW STL, systems engineering ond technicol direction

MAJOR CONTRACTOR: Boeing Co., mojor contractor ond systems integrotor; Avco, re-entry vehicle

FRAME TYPE & CONFIGURATION: Three-stoge; length, A, 53.7 ft.; B, 55.9 ft.; F, 59.B ft.; diometer ot interstoge junction, 6.2 ft.; weight, 65,000 lbs.

PROPULSION CONTRACTOR: Thiokol/Aerojet/Hercules, respectively by stoges

PROPULSION TYPE: Solid propellont

GUIDANCE CONTRACTOR: Autonetics

GUIDANCE TYPE: All-inertiol

PAYLOAD: Nucleor worheod

PERFORMANCE: Ronge, 6,300 n. mi.; speed, over 15,000 mph; opogee, 700 miles; reoction time, 32 sec.; torget selection time, less thon 10 sec.; yield, obout one megoton

REMARKS: Force size now outhorized 1,000 missiles, 600 missiles were operotionol in June, 1964; 800 will be in operotion by June, 1965, completing A & B progroms; Molmstrom only bose with ronge-deficient A version; deployed ot Molmstrom AFB, Mont., Ellsworth, S.D., Whitemon, Mo., Minot, N.D., Grond Forks, N.D.; ond Worren AFB, Wyo.; lounched from underground silos; F version with improved second stoge ond guidonce con be lounched by oeriol commond post signol

MMRBM (Air Force)

TYPE: Mobile medium-ronge bollistic missile

STATUS: Engineering development; if Congress refuses to restore o $70-million FY '65 cut, progrom will probobly be concelled; guidonce, commond ond control development will continue

FRAME TYPE & CONFIGURATION: Length, obout 30 ft.; weight, 11,000 lbs.; entire system contoined in one vehicle; missile ejected from truck before motor ignition

PRIME CONTRACTOR: Hughes, integrotion, ossembly & checkout; Aeronutronic/Foirchild Strotos/Sperry Rond, re-entry system; Hughes/Mortin/Sylvonio, commond & control

PROPULSION CONTRACTOR: Thiokol

PROPULSION TYPE: Two-stoge solid propellont

GUIDANCE CONTRACTOR: Generol Precision

GUIDANCE TYPE: Stellor inertiol

PAYLOAD: Nucleor

GROUND EQUIPMENT CONTRACTORS: Goodyeor Aerospoce, transporter-erector-louncher

PERFORMANCE: Ronge, 300-1,500 n. mi.; extremely mobile; short reoction time

REMARKS: Designed to fill the ronge gop between Pershing & Poloris missiles; mobility must be compotible with rood nets of Europe ond Asio; commond-control problems considered greater thon usuol

GENERAL ELECTRODYNAMICS CORPORATION

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Camera tubes
Special purpose tubes
Scan conversion tubes

TD 8484

High sensitivity, low lag vidicon. The improved photoconductive coating also is resistant to burn-in and has excellent uniformity. High quality pictures can be obtained with as little as 0.2 foot-candles of faceplate illumination. This tube supersedes TD 7325 and TD 7735A.



TD 8507

High resolution, separate mesh vidicon. Has same photoconductive coating as the TD 8484, therefore also provides high sensitivity, excellent uniformity and is resistant to burn-in.



TD 1337

Hybrid Industrial Vidicon featuring electrostatic focus and magnetic deflection. Has same high sensitive characteristics as TD 8484, and center resolution in excess of 700 lines.



GEC SPECIAL TUBES

TD 7522

Electrostatic focus and deflection vidicon. High resolution of approximately 600 lines.

TD 1372

A dual gun storage tube capable of simultaneous reading and writing. Over-all construction permits extremely accurate alignment of both guns.



Slow scan television systems
Scan conversion systems
Special purpose test equipment



ED 6025

Slide Video Generator

Completely transistorized, the 6025 is designed to provide video signals by scanning 35 mm slides. Various scanning formats can be obtained by selecting the appropriate plug-in module.

ED 6021

Universal Scan Converter



This completely solid state system is capable of converting between various scan formats. Typical conversions include: PPI to TV, slow scan to TV, character writing input to TV output simply by selecting proper module. The system can be modified to any specific customer requirement. It is designed around the TD 1372 dual gun tube.



ED 6038

Transistorized Environmental TV Camera

Its miniature and rugged design provides for high detail, stable pictures under the severest vibration, shock and noise conditions of missile and space vehicle environments. The system was designed around the GEC ½" Hybrid Vidicon.

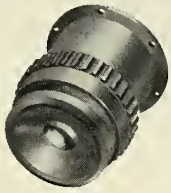
ED 6030

Slow Scan TV System

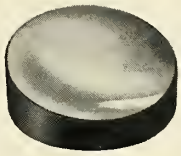


Completely transistorized, the ED 6030 consists of camera head, camera control, monitor and power supply. The system provides continuously variable control of the scanning frequency over a range of 100:1.

Custom optical components
Optical systems
Optics for electronics



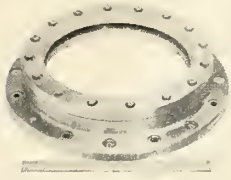
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Circle No. 18 on Subscriber Service Card



Ling's high-force thrusters simplify large package testing

Multi-unit array of Ling's Model 310 Thruster provides unlimited force capability.

Problems related to testing of massive packages have been solved by the multi-unit application of the Ling Model 310 Thruster. Government agencies and prime contractors are now employing Thruster Clusters on practical tests. Compact thrusters apply vibration forces directly to selected input points of larger specimens. Frequency range is 5 to 2,500 cps and each thruster has a force rating of 10,000 pounds. Force ratings to 100,000 pounds are readily achieved. Lightweight armature elements allow excitation of the test package with a controlled forcing function, yet with a minimum of undesirable loading. Model 311 Base supports the thruster in the vertical position. A volume of air under pressure provides a 2 cps natural frequency suspension for the isolation of high forces at low frequencies. Model 312 Base supports the thruster in the horizontal position; the support base provides isolation of the thruster body from the leveling base. Model 313 supports the thruster in the vertical position, and is designed for rigid attachment to a supporting base structure when isolation is not desired. Air bearing surfaces on the base substructures are utilized in the 311 and 312 bases to permit precise alignment to the load. In common with all Ling Shakers the 310 Thruster is readily adaptable to environmental chamber application. For details of Model 310. and complete explanation of concept, write Ling, Dept. MR-764, at the address below.

LTV

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Circle No. 19 on Subscriber Service Card

Pershing (MGM-31A) (Army)

TYPE: Two-stage ballistic missile

STATUS: Operotional

PRIME CONTRACTOR: Martin/Orlando

FRAME CONFIGURATION: Length, 35 ft.; diometer, 40 in.; weight, 10,000 lbs.

PROPULSION CONTRACTOR. Thiokol

PROPULSION TYPE: Two-stage solid-propellont

GUIDANCE CONTRACTOR: Eclipse-Pioneer Div., Bendix

GUIDANCE TYPE: Inertial

PAYLOAD: Nucleor warhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., XM-474 trocked vehicles; Universol Motch Corp., transporter/erector/louncher; Collins Rodio, communicotions

PERFORMANCE: Range, 100-400 n. mi.; speed, supersonic

REMARKS: Has replaced all Redstone units; completely mobile; system is corried on four tracked vehicles; consideration being given to increasing the number af launchers per battalion to six; West Germony procuring



PERSHING

Polaris (UGM-27 A, B, C) (Navy)

TYPE: Surfoce-to-surfoce strategic missile fired from submerged submorines

STATUS: Operationol in two af its three versions; A-3 to be operational in August, 1964

PRIME CONTRACTOR: Lockheed

FRAME TYPE & CONFIGURATION: A-1 length, 28 ft.; diameter, 4-5 ft.; weight, 28,000 lbs.; A-2 & A-3 length, 30.5 ft., diometer, 4.5 ft.; weight, 30,000 lbs.

PROPULSION CONTRACTOR: Aerojet-General/Hercules

PROPULSION TYPE: Solid

GUIDANCE CONTRACTOR: GE/MIT/Hughes

GUIDANCE TYPE: All-inertial

PAYLOAD: Nucleor worhead, about one megotan

EQUIPMENT CONTRACTORS: Nortranics, checkout; Westinghouse, lounch equipment; Vitro, systems engineering coordination ond troining; Systron-Donner, ignition progromming

PERFORMANCE: Range A-1, 1,200 n. mi.; A-2, 1,500 n. mi.; A-3 2,500 n. mi.; speed obout 8,000 mph

REMARKS: Sixteen submarines, each with 16 missiles aperotionol with A-1 ond A-2; totol authorized fleet ballistic missile submarine progrom is 41 ships with all to be operotional by the end af FY '67; subs now deployed in Atlontic ond Mediterroneon, with Pocific servicing focilities under construction; British to buy missiles from U.S. for Royol Novy; George Woshington being retrofitted with A-3; in oddition, subs 2-5 ond 19-41 will hove A-3; 6-18 will retoin A-2; B-3 version with as much as o 50% increose in ronge/poylood under study

POLARIS



Regulus (RGM-6) (Navy)

TYPE: Surfoce-to-surfoce air-breathing missile

STATUS: Operational

PRIME CONTRACTOR: Ling-Temco-Vought

FRAME TYPE & CONFIGURATION: Length, 34 ft.; wingspan, 21 ft.; diameter, 4.5 ft.; weight 14,000 lbs.

PROPULSION CONTRACTOR: Aerojet/Allison

PROPULSION TYPE: Solid rocket booster/J-33 turbojet

GUIDANCE CONTRACTOR: Sperry

GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear worhead

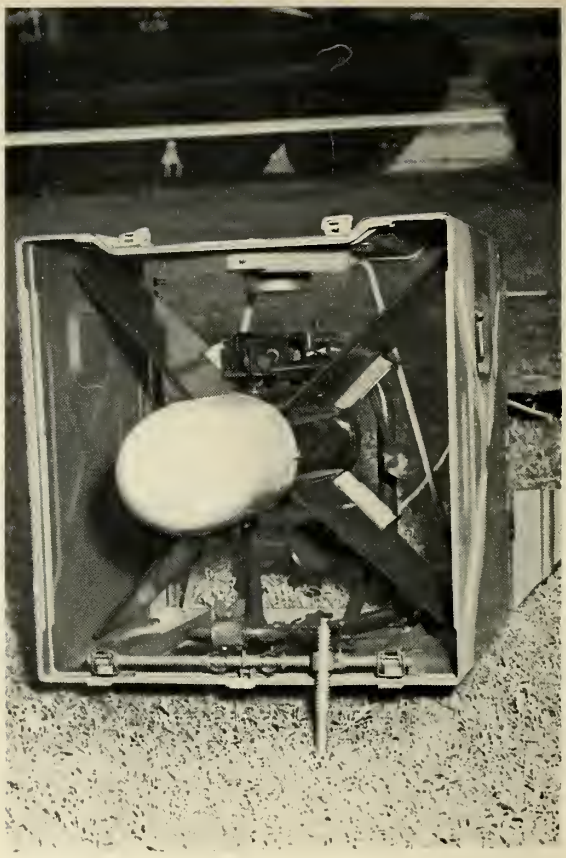
EQUIPMENT CONTRACTORS: Fruehouf, louncher & tronsport vehicles

PERFORMANCE: Ronge, 500 n. mi.; speed, 600 mph; ceiling, over 40,000 ft.

REMARKS: Five operational subs with 17 missiles in the fleet; three af these subs with eight missiles will be phosed out in FY '65



SERGEANT



SS-10

Sergeant (MGM-29A) (Army)

TYPE: Single-stage ballistic missile

STATUS: Operatianal

PRIME CONTRACTOR: Sperry Utah Ca.

FRAME CONFIGURATION: Length, 34.5 ft.; diameter, 31 in.; weight 10,000 lbs.

PROPULSION CONTRACTOR: Thiakal

PROPULSION TYPE: Single-stage salid-propellant, emplays drag brakes in terminal phase

GUIDANCE CONTRACTOR: Sperry

GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: Fruehauf, transpart vehicles; AMF, erector/launcher; AiResearch, gas turbine generatars

PERFORMANCE: Range 25-75 n. mi.; speed, supersanic

REMARKS: Pracurement completed in FY '64; all Carporal units replaced by Sergeant; Germany buying

SS-10 (Army)

TYPE: Surface-to-surface antitank missile

STATUS: Operatianal

PRIME CONTRACTOR: Nard Aviatian, prime; GE, U.S. licensee

FRAME TYPE & CONFIGURATION: Length, 34 in.; diameter, 6 in.; wingspan, 30 in.; weight 33 lbs.; crucifarm wings

PROPULSION TYPE: Salid propellant

GUIDANCE TYPE: Wire-guided

PAYLOAD: High-explasive shaped charge

PERFORMANCE: Range, 1,600 yds.; speed, 180 mph

REMARKS: In service with U.S. farces in Eurape; being replaced with ENTAC

Shillelagh (MGM-51A) (Army)

TYPE: Tactical guided missile far infantry suppart

STATUS: Operatianal evaluation

PRIME CONTRACTOR: Aeronutronic

FRAME CONFIGURATION: Diameter, 152 mm; weight, 40 lbs.

PROPULSION CONTRACTOR: Picatinny Arsenal/Amoca Chemicals Carp.; Norris Thermadar, matar cases

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Aeranutronic

GUIDANCE TYPE: Cammand

PAYLOAD: High-explasive warhead

GROUND EQUIPMENT CONTRACTORS: Cadillac Matar Div., General Matars, supplies the General Sheridan armared recannaissance, airborne assault vehicle armed with Shillelagh

PERFORMANCE: Classified

REMARKS: First pracurement in FY '65 ta be used against tanks, pillbaxes and ather hardpaint targets; being tested at White Sands Missile Range; will use multi-system test equipment; Army alsa investigating use of missile from airborne platfarms

Subroc (UUM-44A) (Navy)

TYPE: Antisubmarine racket

STATUS: Operatianal evaluatian

PRIME CONTRACTOR: Gaadyear Aeraspace

FRAME CONFIGURATION: Length, 21 ft.; diameter, 21 in.; weight, 4,000 lbs.

PROPULSION CONTRACTOR: Thiakal

PROPULSION TYPE: Solid racket

GUIDANCE TYPE: Inertial

GUIDANCE CONTRACTOR: General Precisian/Aeraspace

PAYLOAD: Nuclear or high-explasive warhead

EQUIPMENT CONTRACTORS: Librascope, fire cantrol; AiResearch, auxiliary power

PERFORMANCE: Range, 25-30 mi.

REMARKS: Fired fram submarine tarpeda tubes, leaves water in flight, re-enters water and seeks enemy submarine; first system was aboard Thresher, and loss of that sub set evaluatian pragram back

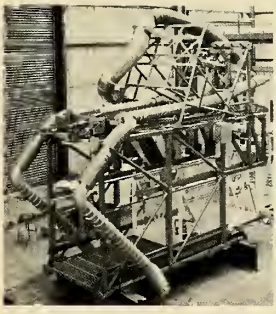
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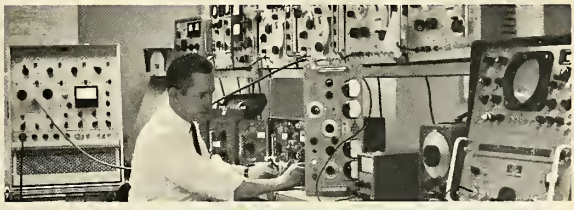
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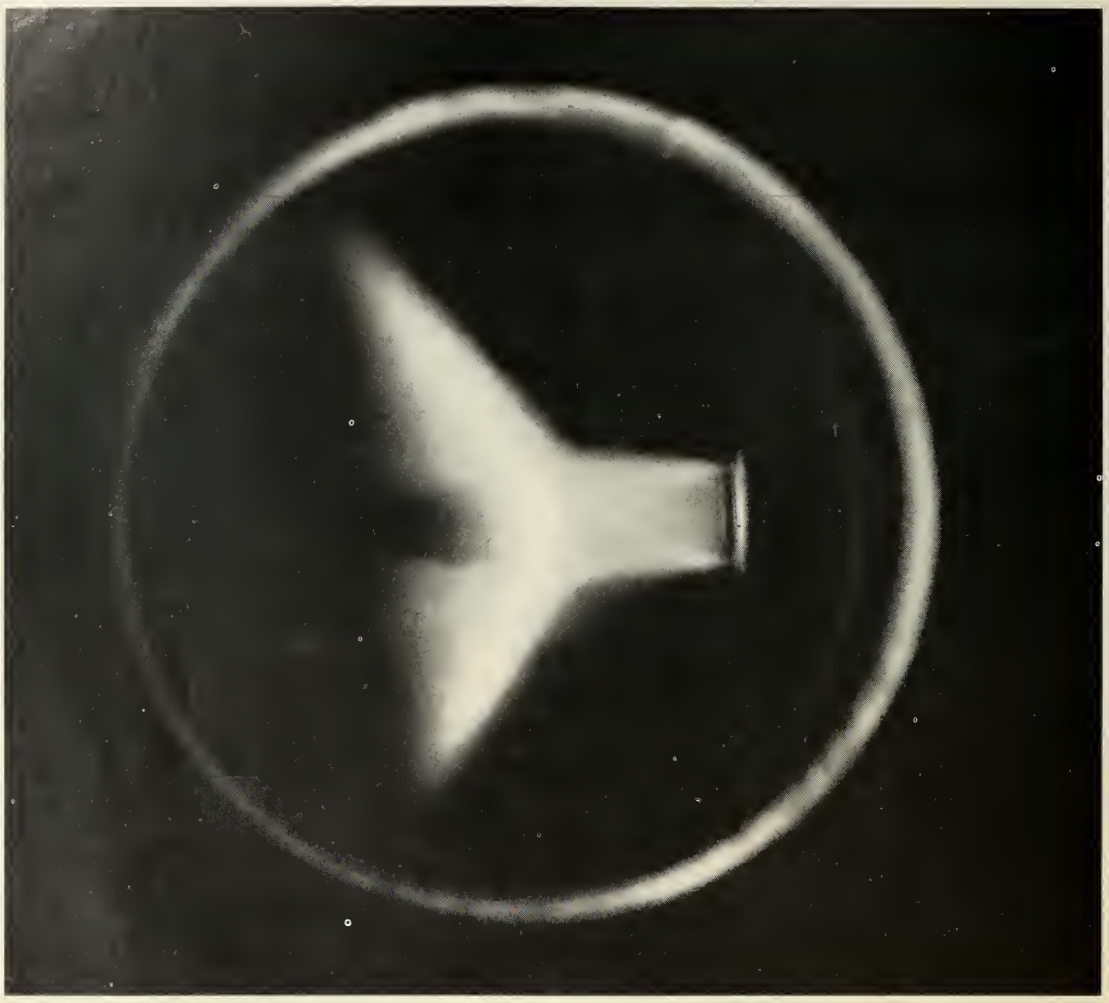
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This research tool is one of many B.F.Goodrich uses to evaluate and upgrade materials for re-entry vehicle requirements. Given desired performance data, BFG can formulate new polymers, compound new materials, evaluate and test, set up and operate a pilot plant for small-scale production quantities.

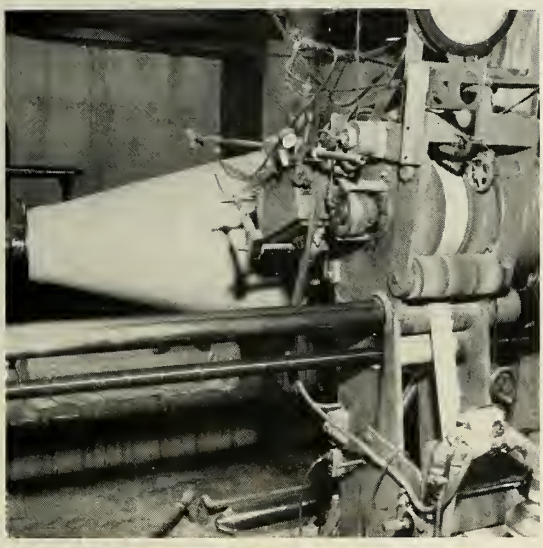
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fabrication development . . . to finished heat shield



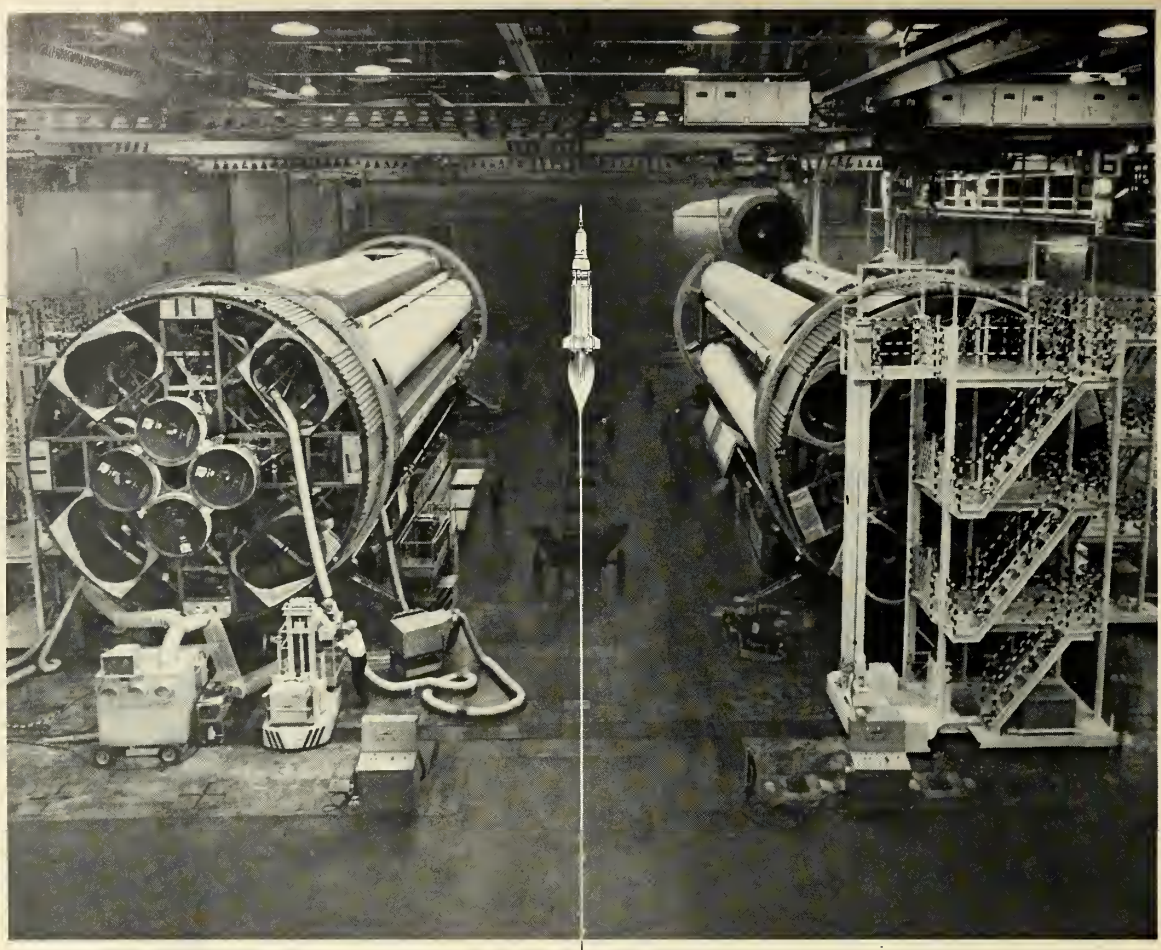






Re-entry vehicle heat shield produced for Bendix Corporation.

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SPACE DIVISION **CHRYSLER CORPORATION**

Circle No. 21 on Subscriber Service Card



TOW

Titan I (HGM-25A) (Air Force)

TYPE: ICBM

STATUS: Operational

PRIME CONTRACTOR: TRW STL, systems engineering and technical direction; Frame, Martin/Denver

FRAME TYPE & CONFIGURATION: Length, 98 ft.; diameter, first stage 10 ft., second stage 8 ft.; weight 220,000 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSON TYPE: Liquid propellants, LOX/RP-1; two engines first stage, one engine second stage; 300,000 lbs. thrust first stage, 80,000 lbs. thrust second stage

GUIDANCE CONTRACTOR: Bell/Sperry Rand

GUIDANCE: TYPE: Radio-inertial

PAYLOAD: Nuclear warhead, yield about 15 megatons

GROUND EQUPMENT CONTRACTORS: AMF, launch facilities; North American, transport vehicles

PERFORMANCE: Range, 6,300 n. mi.; speed, 16,000 mph; apogee, 920 n. mi.

REMARKS: 54 missiles deployed at five bases; phaseout planned beginning in FY '66

Titan II (LGM-25C) (Air Force)

TYPE: ICBM

STATUS: Operational

PRIME CONTRACTOR: TRW STL, systems engineering and technical direction; Frame, Martin/Denver

FRAME TYPE & CONFIGURATION: Length, 103 ft.; diameter, 10 ft.; weight, 330,000 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Liquid propellants, nitrogen tetroxide and a 50/50 mixture of hydrazine and UDMH; two engines first stage, one engine second stage; 430,000 lbs. thrust first stage; 100,000 lbs. thrust second stage

GUIDANCE CONTRACTOR: AC Spark Plug

GUIDANCE TYPE: Inertial

PAYLOAD: Nuclear warhead; about 20 megatons; re-entry vehicle, General Electric

GROUND EQUIPMENT CONTRACTORS: AMF, launch facilities; North American, transport vehicles

PERFORMANCE: Range, over 6,300 n. mi.; speed, over 16,000 mph

REMARKS: Greatest payload & range of any U.S. ICBM; carries most sophisticated and effective penetration aids of any U.S. missile; constitutes basic core vehicle for Titan III; all squadrons operational at 3 bases (54 missiles total); to be used as Gemini space booster

TOW (Army)

TYPE: Antitank missile

STATUS: Engineering development

PRIME CONTRACTOR: Hughes

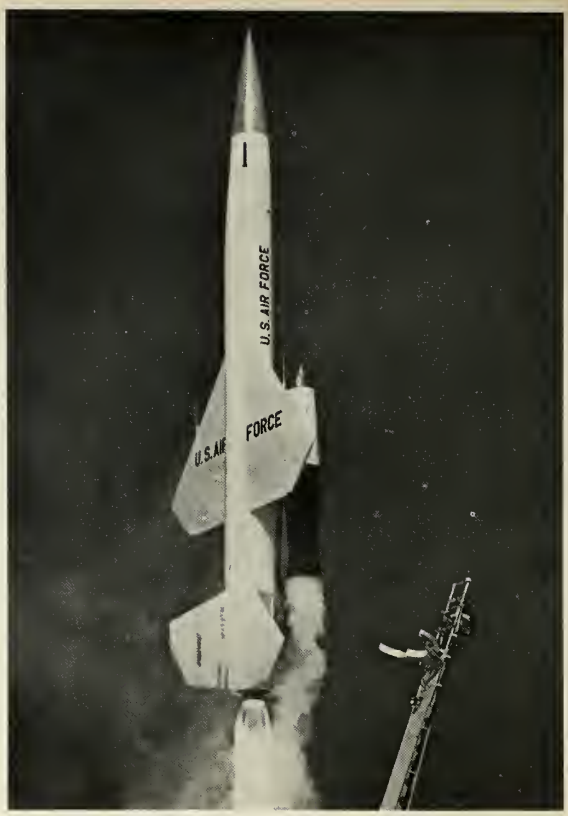
FRAME TYPE & CONFIGURATION: Tube-launched, optically-tracked, wire-guided; weight, 160 lbs.

PROPULSION TYPE: 2-stage solid propellant—one charge to eject round from launch tube before second motor ignited

GUIDANCE TYPE: Wire-guided through a link in the optical sight

PAYLOAD: High-explosive shaped charge

REMARKS: Replacement for ENTAC; bore-sighted firings being conducted at Army Missile Command; in-flight motor ignition problems being encountered



BOMARC

AADS-70 (Army)

TYPE: Surface-to-air air defense missile system

STATUS: Pre-program definition

PRIME CONTRACTOR: Hughes teamed with Douglas, and FMC and RCA with Beech, selected to do component development work on the system during the coming year.

CONFIGURATION: System intended to provide defense for field army against 1970 version tactical ballistic missiles and aircraft; similar to Mauler entire system was to have been mounted on a single vehicle, but Army sources say only that it has to be mounted on the "minimum" number of vehicles

REMARKS: Some $2 million dollars spent to date, with $5 million more in FY '65; expense is one reason for delay in development; also target acquisition and missile guidance are pushing state of the art; system, or one like it, would be required to protect Nike-X from air-breathing cruise missile threat

Advanced Standardized Missile System (Navy)

TYPE: Surface-to-air for fleet air defense

STATUS Program definition

PRIME CONTRACTOR: Teams for competition are: Westinghouse/Bendix-Mishawka/NAA-Columbus, Boeing/TRW STL/Collins Radio/Litton/Bendix Radio Div., Sperry/General Dynamics-Pomona/Univac, Hughes/Douglas-Charlotte/Northern Ordnance, RCA/Martin and GE/Douglas Missiles & Space Systems Div.

CONFIGURATION: Missile will combine components of Terrier and Tartar systems into a single standardized weapon; must be compatible with existing shipboard launch systems

PROPULSION: Solid

PAYLOAD: High explosive warhead

REMARKS: Development expected to begin in FY '65

Anti-Satellite Weapon (Air Force)

TYPE: Ground-launched missile for destruction of hostile spacecraft

STATUS: Full-scale development

PRIME CONTRACTOR: None announced; AF Space Systems Div. is managing program, with Navy's Bureau of Yards and Docks doing construction work at Johnston Island

CONFIGURATION: Thor and Thrust-Augmented Thor will be used as booster, with Agena D upper stage; final maneuvering to the target will be done by radar-homing third stage

SCHEDULE: Flight tests expected as early as late 1965 or early 1966

REMARKS: System being developed as "insurance" against any Soviet space threat that may appear; safeguard guarantees of the Nuclear Test Ban Treaty are being used as a cover for the program

Bomarc (CIM-10A & 10B) (Air Force)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Boeing

FRAME TYPE & CONFIGURATION: Length, 46.9 ft. (B, 45 ft.); wingspan, 18.2 ft.; diameter, 35 in., weight 15,000 lbs.

PROPULSION CONTRACTOR: Thiokal/Morquardt

PROPULSION TYPE: Solid rocket booster, ramjet sustainer

GUIDANCE CONTRACTOR: IBM/Westinghouse/General Precision

GUIDANCE TYPE: Command via SAGE system, then active radar homing to target

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., launcher/erector

PERFORMANCE: Range, over 200 n. mi. (B, 400 n. mi.); speed, Mach 2.5; ceiling, over 68,000 ft. (B, over 90,000 ft.); B also has low-altitude capability

REMARKS: 195 Bomarc A's and 188 Bamarc B's operational at eight bases; all A missiles will be phased out in FY '65 and B missiles will be distributed among six sites

Hawk (MIM-23A) (Army)

TYPE: Surface-to-oir defense missile ogoinst low-flying planes

STATUS: Operotionol

PRIME CONTRACTOR: Raytheon

FRAME CONTACTOR: Northrop Nortronics, system controctor

FRAME TYPE & CONFIGURATION: Length, 16.8 ft.; diameter, 14 in.; weight, 1,275 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Solid propellont, duol stoge

GUIDANCE CONTRACTOR: Raytheon

GUIDANCE TYPE: Semi-active rador homing

PAYLOAD: High-explosive worhead

GROUND EQUIPMENT CONTRACTORS: Mechonicol GSE, Northrop Nortronics; guidance GSE, Raytheon; test equipment, RCA; louncher/looder/corrier, FMC Corp.; radar pedestals, Bendix; rodar ontennos, Goodyeor

PERFORMANCE: Ronge, 22 mi.; speed, supersonic; ceiling, 100 to 45,000 ft.

REMARKS: Procurement complete; deployed in Europe, Panoma, Okinowo, and the U.S.; bought by Sweden and Israel; odvonced Hawk being developed for antitocticol-missile use; has intercepted Corporal, Honest John ond Little John rockets in flight

HIBEX (ARPA/ Army)

TYPE: Experimentol progrom in high-energy propellonts

STATUS: Development

PRIME CONTRACTOR: Boeing

CONFIGURATION: Classified

PERFORMANCE: Classified

PROPULSION CONTRACTOR: Hercules, double bose; Aerojet, composite

PROPULSION: High-energy solid

REMARKS: Army Missile Commond monoging progrom for ARPA; accelerotions of 800-1,000 g's gool; flight-test progrom of 24 vehicles to be conducted ot WSMR

Mauler (XMIM-46A) (Army)

TYPE: Surface-to-air antoircroft/ ontimissile system

STATUS: Engineering development

PRIME CONTRACTOR: General Dynomics/Pomono

FRAME CONTRACTOR: GD/Pomona

FRAME TYPE & CONFIGURATION: Dort-shaped; length, about 6 ft.; diameter, 5 in.; weight, 120 lbs.; each firing unit has nine missiles, 3 rows of 3 missiles each

PROPULSION CONTRACTOR: Lockheed

PROPULSION TYPE: Single-stoge solid propellant

GUIDANCE CONTRACTOR: Hughes, guidonce; deHovillond of Conado, infrored ocquisition system; Raytheon, rodor; Burroughs, computer

GUIDANCE TYPE: Sky-sweeping acquisition radar, torget-illuminoting pinpoint rodor, then IR-homing for terminol phose

PAYLOAD: High-explosive worhead

GROUND EQUIPMENT CONTRACTORS: FMC Corp., XM-546 self-propelled trocked vehicle

PERFORMANCE: Designed to ropidly engage and destroy enemy supersonic aircroft ond rockets in the Honest John/Little John class while moving ocross o bottlefield with front-line troops

REMARKS: Pockoging difficulties have required o feosibility demonstration progrom to prove system's worth; fully air-tronsportable; weapon pod contoins oll fire control and lounch equipment os well as 9 missiles; pad con be removed for permanent emplacement if desired; system hos three crew members, but can operate with two



HAWK

MAULER





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NIKE-HERCULES

Nike-Hercules (MIM-14B) (Army)

TYPE: Surface-ta-air air defense missile

STATUS: Operatianal

PRIME CONTRACTOR: Western Electric

FRAME CONTRACTOR: Douglas

FRAME TYPE & CONFIGURATION: Length, 41 ft.; diameter, 31.5 in.; weight, 10,000 lbs.

PROPULSION CONTRACTOR: Thiakal

PROPULSION TYPE: Twa-stage salid prapellant

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Cammand; system uses law-pawer acquisitian, high-pawer acquisitian, target-tracking, and missile-tracking radars in canjunctian with electranic data-processing gear

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: Launchers, Cansalidated Western Steel; transpart vehicles, Fruehauf; graund guidance, Western Electric

PERFORMANCE: Range, aver 75 n. mi.; ceiling, 100,000 ft.; speed, aver Mach 3

REMARKS: Over 80 batteries deplayed in U.S.; 10 batteries deplayed averseas in Eurape and an Taiwan; being equipped with Hipar, a high-pawer acquisitian radar, far anti-tactical ballistic missile capabilities; plan ta relacate same Nike-Hercules batteries under consideratian by DOD

Nike-X (Sprint) (Army)

TYPE: Surface-ta-air A-ICBM missile

STATUS: Develapment

PRIME CONTRACTOR: Martin

FRAME TYPE & CONFIGURATION: Smaller than Nike-Zeus, but canfiguratian details unavailable

PROPULSION CONTRACTOR: Hercules/Lackheed

PROPULSION TYPE: Salid prapellant; extremely high acceleratian

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Cammand; will be mixed with Zeus missiles in batteries contralled by multi-function array radar; campanents must withstand tremendaus g farces

PAYLOAD: Nuclear warhead

PERFORMANCE: Range, classified; speed, classified; acceleratian, extremely high

REMARKS: Will engage enemy ICBM's at relatively law altitudes ta allaw the atmasphere ta strip away decays and permit clearer discriminatian by defensive radar; missile will be "popped" fram sila befare ignitian and flight ta target

Nike-X (Army)

TYPE: Dual-missile (Zeus and Sprint) A-ICBM system

STATUS: Develapment

PRIME CONTRACTOR: Western Electric

FRAME TYPE & CONFIGURATION: Dauglas, Zeus frame; Martin-Orlanda, Sprint frame; Sprint is smaller than Zeus but its canfiguratian is unknawn

PROPULSION CONTRACTOR: Thiakal, Zeus prapulsian; Hercules/Lackheed, Sprint prapulsian

PROPULSION TYPE: Salid prapellants; three Zeus stages; twa Sprint stages

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Cammand; will use MAR (multi-functian array radar) instead af three separate radars far acquiring & tracking target as regular Zeus system daes; Missile Site Radar (MSR) will handle mare than ane defensive missile at a time

PAYLOAD: Nuclear warheads far bath Zeus and Sprint

PERFORMANCE: Zeus—range aver 200 n. mi.; speed, aver Mach 4. Sprint—classified, but extremely high acceleratian required

REMARKS. Nike-X uses advanced MAR radar and Sprint missile ta greatly enhance capabilities against ICBM's af 1970's; each Nike-X battery will cantain mix af Zeus and Sprint missiles ta allow flexibility in engaging enemy warheads at high (Zeus) ar law (Sprint) altitudes; system can acquire, track, and engage a number af targets simultaneausly, firing either missile fram "mix" available; new canputers will allaw greater speed and data-handling capacity; experimental MAR radar will begin tests this summer at White Sands Missile Range

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Nike-X (Zeus) (XLIM-49A) (Army)

TYPE: Surface-ta-air A-ICBM

STATUS: Advanced development as part af Nike-X

PRIME CONTRACTOR: Western Electric

FRAME CONTRACTOR: Douglas

FRAME TYPE & CONFIGURATION: Length, 48.3 ft.; diameter, (sustainer) 36 in.; fin span, 10 ft.; launch weight, 22,800 lbs.

PROPULSION CONTRACTOR: Thiakol

PROPULSION TYPE: Three-stage solid propellant, with "jet-head" system for manuevering in space; acceleration very high

GUIDANCE CONTRACTOR: Western Electric

GUIDANCE TYPE: Command; system uses acquisition radar, target-track radar and missile-track radar in conjunctian with electronic data-processing gear

PAYLOAD: Nuclear warhead

GROUND EQUIPMENT CONTRACTORS: Goodyear Aerospace, acquisition radar antennas; Allis-Chalmers/Continental Can/NARMCO, target-track antenna; Steel Praducts Engineering, missile-track antenna; Remington Rand Univac, camputers; Burns & Rae, Inc., technical facilities design; Stramberg Carlson, test sets

PERFORMANCE: Slant range, about 200 n. mi.; speed, over Mach 4

REMARKS: Missile has become part af the Nike-X missile "mix;" highly successful intercept program has been essentially completed; third stage components have been repackaged and a more pawerful booster added

Redeye (MIM-43) (Army)

TYPE: Shoulder-fired antiaircraft missile

STATUS: Procurement

PRIME CONTRACTOR: General Dynamics/Pomona

FRAME TYPE & CONFIGURATION: Bazooka-type, wingless cylindrical weapon; length, 44 in.; diameter, 2.75 in.; weight, 28 lbs.

PROPULSION CONTRACTOR: Atlantic Research

PROPULSION TYPE: Single-stage solid propellant

GUIDANCE CONTRACTOR: Philco/GD-Electronics

GUIDANCE TYPE: Infrared

PAYLOAD: High-explosive warhead

PERFORMANCE: Range, classified; speed, supersonic

REMARKS: Procurement funds for both Army and Marines were cut from FY '65 budget by Congress; DOD protesting cut

Tactical Probe (Navy)

TYPE: Surface-to-air probe

MISSION: To gather meteorological and electronic warfare data and provide emergency communications

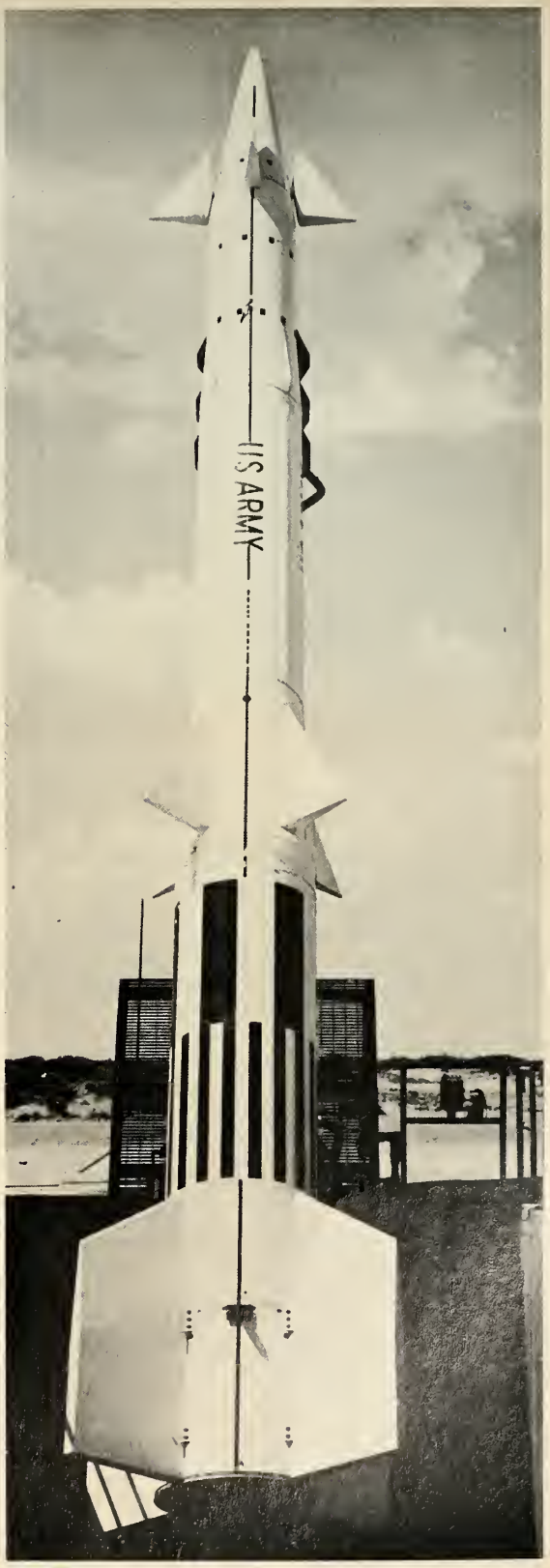
STATUS: Program definition

PRIME CONTRACTOR: Bendix and Astronautics Div. of Ling-Temco-Vaught are thought to be the front-runners in the program; one of the two will be selected for the $40-million development

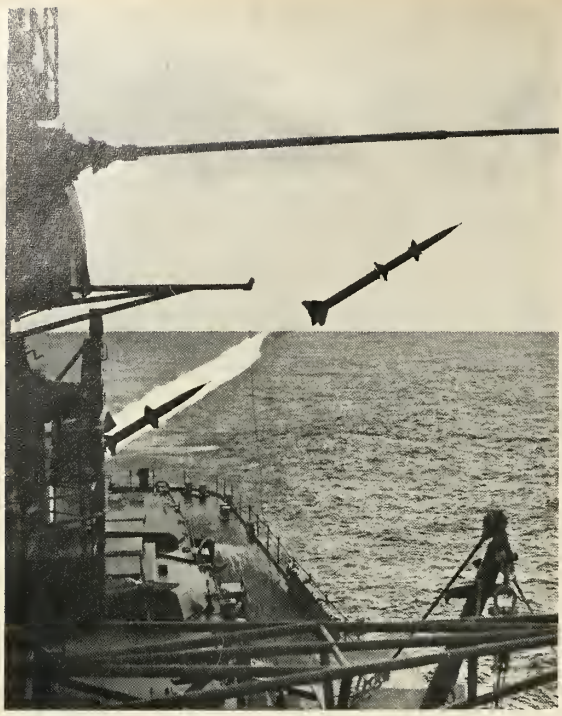
CONFIGURATION: Consists of multiple, interchangeable payloads for each mission; launched by Terrier or Talos from present shipboard installations; has a high-impulse second stage

PERFORMANCE: Range 50-300 miles from launching ship; descent would be by parachute in which 15 minutes of useful data could be telemetered back to the ship

REMARKS: Navy has been tald by DOD to restudy its requirement to come up with a cheaper program



NIKE-ZEUS



TARTAR



TERRIER

Talos (RIM-8E) (Navy)

TYPE: Surface-to-air cruise missile for long-range fleet air defense

STATUS: Operational

PRIME CONTRACTOR: Bendix Mishawaka, assembly and test; Vitro, systems engineering

FRAME TYPE & CONFIGURATION: Two stages; overall length, about 30 ft.; diameter about 30 in.; weight 7,000 lbs., 4,000 of which is 10-ft.-long booster

PROPULSION CONTRACTOR: Allegany Ballistics Laboratory; propulsion (booster design), development and pilot production; Naval Propellant plant, booster loading

PROPULSION TYPE: Solid propellant booster/ramjet sustainer

GUIDANCE CONTRACTOR: Kearfott Div., GPI, guidance and control system module

GUIDANCE TYPE: Dual; beam-riding to target area, then semiactive homing in terminal phase

PAYLOAD: Nuclear or high-explosive warhead

EQUIPMENT CONTRACTORS: Naval Weapons Plant, launchers; McDonnell, missile frame; Fairchild Stratos, guidance metal parts module

PERFORMANCE: Range, over 65 n.mi.; speed, over Mach 2.5; ceiling, over 90,000 ft.

REMARKS: Operational aboard six cruisers, including nuclear-powered Long Beach; included in Navy's "get well" program to boost the kill rate of the missile

Tartar (RIM-24B) (Navy)

TYPE: Surface-to-air missile for fleet air defense

STATUS: Operational

PRIME CONTRACTOR: GD/Pomona assembly & test; Vitro, systems coordination engineering

FRAME TYPE & CONFIGURATION: Single-stage; length, 15 ft.; diameter, under 18 in.; weight, about 1,500 lbs.

PROPULSION CONTRACTOR: Aerojet-General

PROPULSION TYPE: Dual-burn solid propellant

GUIDANCE CONTRACTOR: General Dynamics/Pomona; target detection device, Philco and Sperry Forrogut

GUIDANCE TYPE: Semi-active radar beam-riding

PAYLOAD: High-explosive warhead

PERFORMANCE: Range, over 10 n.mi.; speed, Mach 2

REMARKS: Deployed aboard 19 destroyers and 2 cruisers equipped with Talos; 17 Tartar ships and one Talos/Tartar ship under construction/conversion; Navy conducting "get-well" program on Tartar to increase its kill rate; will be combined with Terrier in standardized missile

Terrier (RIM-2E) (Navy)

TYPE: Surface-to-air missile for fleet air defense

STATUS: Operational

PRIME CONTRACTOR: General Dynamics/Pomona, assembly & test; Vitro, systems coordination engineering

FRAME TYPE & CONFIGURATION: Two-stage; overall length, 27 ft., with 12-ft. booster; diameter, about 1 ft.; weight, about 3,000 lbs.

PROPULSION CONTRACTOR: Naval Propellant Plant & Atlantic Research, booster & sustainer loading

PROPULSION TYPE: Two-stage; solid-propellant booster & sustainer

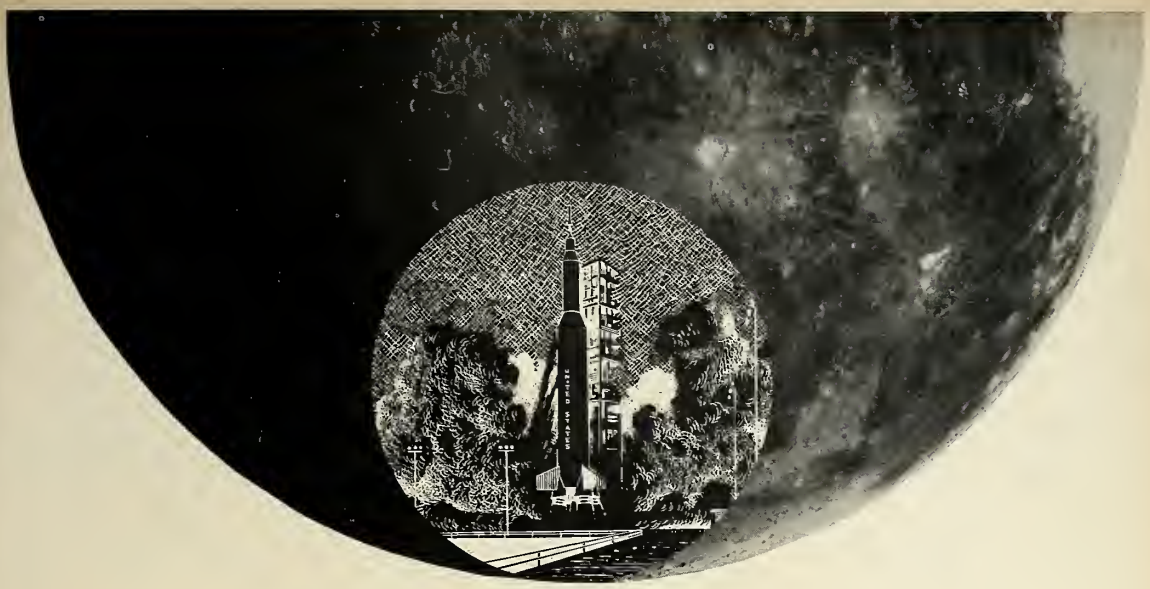
GUIDANCE CONTRACTOR: General Dynamics/Pomona, guidance section

GUIDANCE TYPE: Semi-active radar beam-riding homing

PAYLOAD: High-explosive warhead

PERFORMANCE: Range, over 10 n.mi.; speed, Mach 2.5; ceiling, over 65,000 ft.

REMARKS: Navy has 26 ships in commission with system, 13 more approved for construction/conversion; Navy "Get Well" program continuing; system will be combined w/Tartar in standardized missile



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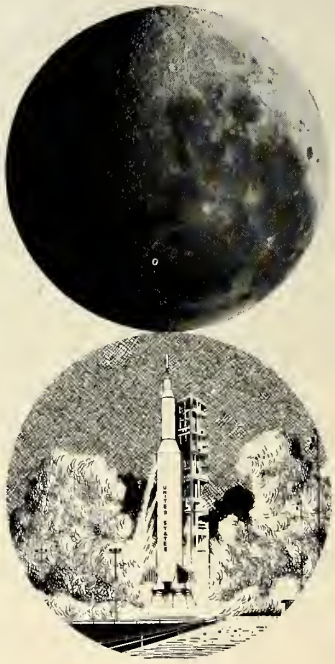
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FALCON

air to air

Falcon (AIM-4A C, E, F AIM-26A /AIM-47A) (Air Force)

TYPE: Fomily of air-to-air combat missiles

STATUS: Operationol

PRIME CONTRACTOR: Hughes

FRAME TYPE & CONFIGURATION: Single-stage; length, 6.5 ft.; diameter, 6 in.; weight, over 100 lbs. (for all except AIM-26A); AIM-26A length, about 7 ft.; diameter, 11 in.; weight, over 200 lbs.; fin span, 20 in.

PROPULSION CONTRACTOR: Thiokol for oll except AIM-47A; Lockheed Propulsion for AIM-47A

PROPULSION TYPE: Solid propellont; thrust vories with missile, but is about 6,000 lbs.

GUIDANCE CONTRACTOR: Hughes

GUIDANCE TYPE: Varies with missile; active rodor homing/infrared homing/hybrid IR-rodor homing

PAYLOAD: Nucleor warhead on AIM-26A; high-explosive warhead on remoinder

PERFORMANCE: Range, over 5 n.mi.; speed, supersanic; ceiling, obove 50,000 ft.

REMARKS: Missiles formerly designated GAR-1, 2, 3 and 4 now AIM-4; GAR-11 now AIM-26A; GAR-9 now AIM-47A; series deployed with NORAD on fighter interceptars; procurement for most versions completed; AIM-47A under development and being evaluated for use on A-11

Phoenix (AIM-54A) (Navy)

TYPE: Air-to-oir missile for F 111B (TFX) aircraft

STATUS: Development

PRIME CONTRACTOR: Hughes

PROPULSION TYPE: Single-stoge, solid propellont

PROPULSION CONTRACTOR: Rocketdyne

GUIDANCE CONTRACTOR: Hughes

PAYLOAD: High-explosive worhead

PEFORMANCE: Details classified, but extensive range and altitude capabilities required

REMARKS: Reportedly similor to cancelled Eagle missile which was to be used with Missileer longdurotion oircraft; each Navy F-111 con corry six missiles

Genie (AIR-2A) (Air Force)

TYPE: Air-to-oir missile

STATUS: Operational

PRIME CONTRACTOR: Douglas

FRAME TYPE & CONFIGURATION: Length, 9.5 ft.; diameter, 17.35 in.; weight, 800 lbs.

PROPULSION CONTRACTOR: Aerojet-Generol

PROPULSION TYPE: Solid propellant

GUIDANCE TYPE: Free-flight

PAYLOAD: Nuclear warhead with proximity fuzing

PERFORMANCE: Range, over 6 n.mi.; speed, about Mach 3; ceiling, above 50,000 ft.

REMARKS: Procurement complete; provides area defense against attocking bombers; carried by NORAD fighter interceptars

Sidewinder I-C (AIM-9D) (Navy, Air Force)

TYPE: Air-to-air missile

STATUS: Operational

PRIME CONTRACTOR: NOTS, technical direction; Philco/GE

FRAME TYPE & CONFIGURATION: Length, 9 ft.; diameter 5 in.; weight, about 155 lbs.

PROPULSION CONTRACTOR: Naval Propellant Plant, Rocketdyne

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Philco/GE

GUIDANCE TYPE: Infrared homing; an interchangeable semi-active radar homing device is also available

PAYLOAD: High-explosive warhead

PERFORMANCE: Range, over 2 n.mi.; speed, supersonic; ceiling, over 50,000 ft.

REMARKS: In use by Navy, Air Force; NATO-built version under test

Sparrow III-6B (AIM-7E) (Navy)

TYPE: Air-to-air missile

STATUS: Operational

PRIME CONTRACTOR: Raytheon

FRAME TYPE & CONFIGURATION: Length, about 12 ft.; diameter, 8 in.; weight, about 350 lbs.

PROPULSION CONTRACTOR: Aerojet-General, Rocketdyne

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Raytheon

GUIDANCE TYPE: Semiactive CW homing

PAYLOAD: High-explosive warhead

PERFORMANCE: Ronge, 8 n.mi.; speed, Mach 3; ceiling, over 50,000 ft.

REMARKS: Supersonic, all weather 360° attack capability; deployed on carrier aircraft; prime armament on F4H interceptors; Sparrow III and IIIA in use

Bullpup (AGM-12 B & C) (Navy, Air Force)

TYPE: Air-to-surface missile

STATUS: Operational

PRIME CONTRACTOR: Maxson Electronics Corp.

FRAME TYPE & CONFIGURATION: B: length, 11 ft.; diameter, 12 in.; weight, 573 lbs. C: length, 13.5 ft.; diameter, 18 in.; weight, 1,800 lbs.

PROPULSION CONTRACTOR: AMF/Naval Propellant Plant

PROPULSION TYPE: Solid propellant; C version has prepackaged liquid propellant

GUIDANCE CONTRACTOR: Maxson

GUIDANCE TYPE: Radio-link command guidance from firing aircraft, pilot uses visual reference

PAYLOAD: High-explosive warhead weighing 250 lbs.; 1,000-lb. nuclear warhead on Bullpup B

PERFORMANCE: Ronge, 6 n.mi. (depending on launch altitude of aircraft); speed, 1,400 mph.; extremely accurate against hard-point targets

REMARKS: C version being procured by the Navy for itself and AF for use on tactical aircraft; Martin, original source, phasing out of production after losing follow-on contract to Maxson; being produced in Europe for NATO

SPARROW



Condor (AGM-53) (Navy)

TYPE: Air-to-Surface

PRIME CONTRACTOR: In-house, Naval Ordnance Test Station

CONFIGURATION: Classified

REMARKS: Intended for use with the Navy version of the F-111

Quail (ADM-20C) (Air Force)

TYPE: Decoy to simulate B-52 bombers

STATUS: Operational

PRIME CONTRACTOR: McDonnell

FRAME TYPE & CONFIGURATION: Length, 12.9 ft.; height, 3.3 ft.; wingspan, 5.5 ft.; width (with wings folded), 2.5 ft.

PROPULSION CONTRACTOR: General Electric

PROPULSION TYPE: J85 turbojet generating 2,450 lbs. thrust

GUIDANCE CONTRACTOR: Guidance Technology, Inc.

GUIDANCE TYPE: Gyroscopic autopilot

PAYLOAD: B-52 electronic simulation and electronic countermeasures equipment

EQUIPMENT CONTRACTORS: Thompson-Ramo-Wooldridge, electronic payload; support system contractor, Bell Aerospace

PERFORMANCE: Range, 250 n.mi.; advanced version, over 400 n.mi.; speed, comparable to B-52; ceiling, over 50,000 ft.

REMARKS: Each B-52 bomber carries Quail decoys to release as it approaches enemy defenses; bomber and decoys fly B-52 style patterns, speed and altitudes over wide area to maximize enemy confusion

Hound Dog (AGM-28) (Air Force)

TYPE: Air-to-surface strategic defense-suppression missile

STATUS: Operational

PRIME CONTRACTOR: North American

FRAME TYPE & CONFIGURATION: Air-breathing cruise type; length, 42.5 ft.; wingspan, 12.2 ft.; height, 9.3 ft.; weight, 9,600 lbs.

PROPULSION CONTRACTOR: Pratt & Whitney

PROPULSION TYPE: J52 turbojet generating 7,500 lbs. thrust at sea level

GUIDANCE CONTRACTOR: Autonetics

GUIDANCE TYPE: All-inertial

PAYLOAD: Nuclear warhead

PERFORMANCE: Range, over 600 n.mi.; speed, over Mach 2; ceiling, over 50,000 ft.

REMARKS: Standoff weapon, Hound Dog will be retained in SAC arsenal for suppression of enemy defenses so that B-52 bombers can penetrate to top-priority targets with primary bomb load; procurement complete with stockpile over 400 missiles

Shrike (AGM-45A) (Navy)

TYPE: Air-to-surface anti-radiation missile

STATUS: Operational evaluation

PRIME CONTRACTOR: Naval Ordnance Test Station-China Lake, Calif.

FRAME TYPE & CONFIGURATION: Similar to Sparrow III configuration

PROPULSION CONTRACTOR: Rocketdyne

PROPULSION TYPE: Solid propellant

GUIDANCE CONTRACTOR: Texas Instruments

GUIDANCE TYPE: Passive all-weather radar-homing

PAYLOAD: High-explosive warhead

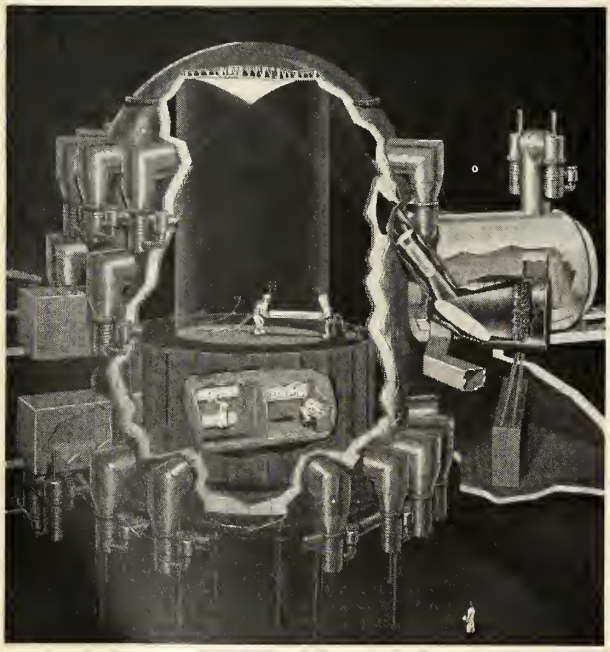
REMARKS: Designed for firing by attack aircraft against enemy radar-controlled air defenses and other radar installations; AF also procuring for TAC

HOUND DOG

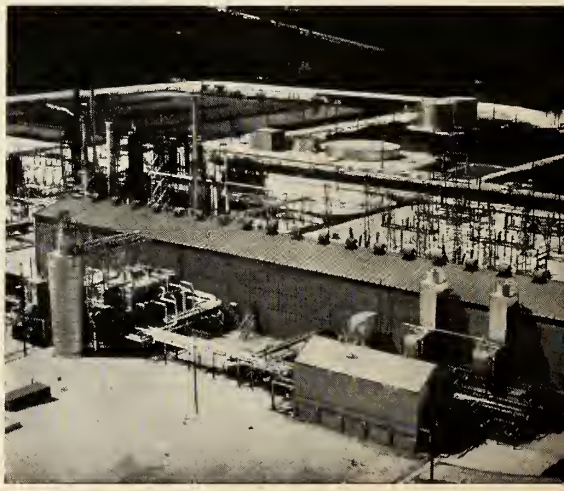




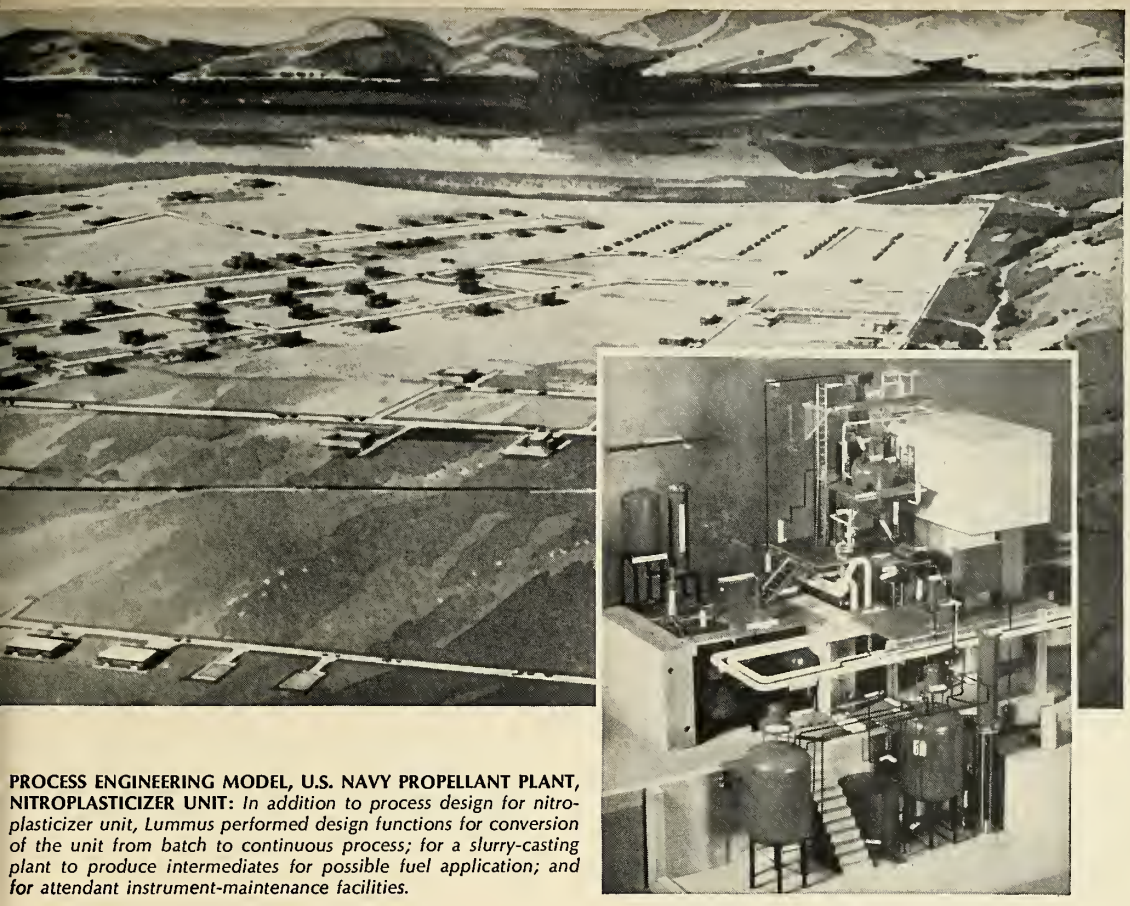
SOLID PROPELLANT PRODUCTION FACILITY–U.S. AIR FORCE PLANT #78: *Lummus' architect/engineering design for this propellant complex included auxiliary facilities for MINUTEMAN horizontal engine testing, propellant handling and storage considerations, and rocket-engine handling.*



LUNAR ENVIRONMENTAL RESEARCH FACILITY–U.S. ARMY CORPS OF ENGINEERS: *Lummus performed the conceptual engineering for this simulator which established the engineering feasibility to provide for vacuums up to 1×10^{-8} torr, temperatures as low as –423°F, and solar radiation twice the intensity of the noonday sun–up to 130 watts/sq. ft.*



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PROCESS ENGINEERING MODEL, U.S. NAVY PROPELLANT PLANT, NITROPLASTICIZER UNIT: *In addition to process design for nitroplasticizer unit, Lummus performed design functions for conversion of the unit from batch to continuous process; for a slurry-casting plant to produce intermediates for possible fuel application; and for attendant instrument-maintenance facilities.*

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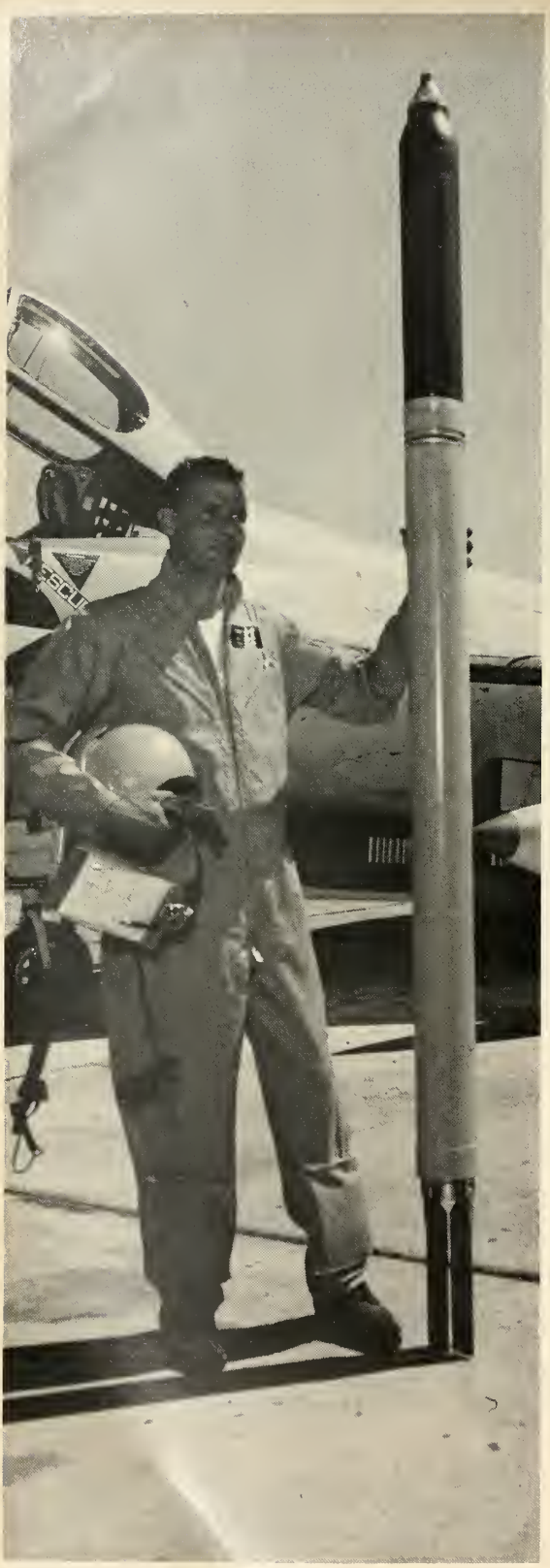
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ZUNI

SS-11 (Army)

TYPE: Air-ta-surface antitank missile

STATUS: Operatianal

PRIME CONTRACTOR: Nard Aviatian

FRAME TYPE & CONFIGURATION: Length, 46 in.; diameter, 6 in.; wingspan, 20 in.; weight, 63 lbs.; swept-back crucifarm wings

PROPULSION TYPE: Solid prapellant

GUIDANCE TYPE: Wire-guided

PAYLOAD: High-explasive shaped charge

PERFORMANCE: Range, 3,800 yds.; speed, aver 400 mph

REMARKS: Employed an UH-IB helicapter with 6-missile launcher

Walleye (Navy)

TYPE: Guided, air-ta-surface bamb

STATUS: Engineering develapment

PRIME CONTRACTOR: Naval Ordnance Test Statian-China Lake

FRAME TYPE & CONFIGURATION: 1,000-lb. bamb equipped with mavable fins

PROPULSION TYPE: Nane

PERFORMANCE: Range af several miles

GUIDANCE CONTRACTOR: Naval Ordnance Test Statian-China Lake

GUIDANCE TYPE: TV cantrast haming guided by pilat after launch

PAYLOAD: High-explasive warhead

REMARKS: Ta be carried by attack aircraft; highly accurate

Zuni (Navy)

TYPE: Air-ta-surface racket far bambardment af graund targets

STATUS: Operatianal

PRIME CONTRACTOR: Naval Ordnance Test Statian-China Lake

FRAME TYPE & CONFIGURATION: Folding fin, all-weather racket; length, 9.2 ft.; diameter, 5 in.; weight, 107 lbs. Hunter-Dauglas Div., Bridgepart Brass Ca.

PROPULSION CONTRACTOR: Naval Prapellant Plant

PROPULSION TYPE: Solid prapellants

GUIDANCE TYPE: Unguided

PAYLOAD: High-explasive warhead

PERFORMANCE: Range, abaut 5 n.mi.; speed, aver Mach 2

REMARKS: Used an many Navy attack and fighter aircraft; AD-type can carry 48; extremely effective as a barrage racket against graund targets

drones

AQM-37A Target Drone

MISSION: Supersanic target drane designed far air-ta-air and surface-ta-air weapan system testing and training

STATUS: Praductian

PRIME CONTRACTOR: Beech

PERFORMANCE: Max. speed, Mach 2; service ceiling, 70,000 ft.

CONFIGURATION: Span, 39 in.; length, 161 in.; diameter (bady), 13 in.; weight, 560 lbs.; frame, swept delta wings with canard cantrals

CONTROL SYSTEM: Twa-axis autapilat

PROPULSION SYSTEM: One Racketdyne liquid-prapellant engine with 630 lbs. thrust

REMARKS: Used by Navy; expendable

Bikini Photo Recon Drone

MISSION: Provide bottlefield commanders with small, lightweight photo reconnaissance drone

STATUS: Development

PRIME CONTRACTOR: Republic

PERFORMANCE: Max. speed, 100 mph; endurance, 45 min; altitude, 10,000 ft.; recon range rodius, 10 mi.

CONFIGURATION: Experimental, but resembles lorge model oirplane; weight, approx. 50 lbs. including camero payload; major materials, reinforced plastic ond off-the-shelf model oirplone parts

GUIDANCE: Radio command; four-channel for rudder, throttle setting, comera octivation ond recovery parachute deployment

PROPULSION: 2-cycle, 2-cylinder, 4½-hp engine driving o propellor

REMARKS: Low-cost vehicle designed for Marine Corps to be used at battolion level; con be operoted by two men throughout mission

CL89 Reconnaissance Drone (Canadian and British Armies)

MISSION: Gother bottlefield intelligence; operote under conditions hozardous for piloted reconnaissance aircroft.

STATUS: Under flight test at Yuma Test Station, Ariz.

PRIME CONTRACTOR: Canadair Ltd., Cartierville, Quebec.

PERFORMANCE: Not avoilable

CONFIGURATION: Approximotely 100 in. long by 36-in. diameter, including four movable fins. Drone fuseloge dio. about 12 in.

GUIDANCE: Not available

PROPULSION: Jet engine with rocket assist, zero-length louncher

REMARKS: The CLB9 project is the result of o common need for a low-cost drone for the Canadian and British armies and the two government's attempts to reduce costs; first project in which the two countries have cooperated so extensively

Firebee Target Drone (Army, Navy, Air Force)

MILITARY DESIGNATION: BQM-34A (Navy, Air Force); BQM-34D (Army)

STATUS: Operationol

PRIME CONTRACTOR: Ryan

PERFORMANCE: Mox. speed, 625 mph; service ceiling, 60,000 ft.; endurance, 75 to 96 min. at 50,-000 ft.

CONFIGURATION: Span, 153 in.; length, 274 in.; height, 79 in.; mox. weight, 2,500 lbs.

GUIDANCE: Radio command ond rodar

PROPULSION SYSTEM: One Continental J-69-T-29 with 1,700 lbs. thrust

SUPPORT EQUIPMENT: Air- or ground-launched; recoveroble by parachute

REMARKS: Primary using commands are Navy, fleet troining; RDT&E; USAF, Air Defense Command; Army Missile Commond, Air Defense Center

Firebee Target Drone (Navy)

MILITARY DESIGNATION: AQM-34B, AQM-34C

STATUS: Operationol

PRIME CONTRACTOR: Ryan

PERFORMANCE: Max. speed, 575 mph; service ceiling, 40,000 ft.; endurance, 60 min.

CONFIGURATION: Span, 135 in.; length, 211 in.; height, 75 in.; max. weight, 1,B4B lbs.

GUIDANCE: Radio command ond radar

PROPULSION SYSTEM: One Continental J-69-T-19 engine with 1,000 lbs. thrust (AQM-34B); one Fairchild J-44-R-20 engine with 1,000 lbs. thrust (AQM-34C-4)

SUPPORT EQUIPMENT: Air- or ground-launched; recoveroble by parachute

Jindivik MK-3A Target Drone

STATUS: Operationol

PRIME CONTRACTOR: Ling-Temco-Vought, Inc.

PERFORMANCE: 100 ft. to 65,-000 ft. operotional oltitudes; Moch 0.B6

CONFIGURATION: Wing-tip extensions for very high oltitude flight; span, 25 ft. B in.; length, 26 ft. 9 in.; gross weight, 3,100 lbs.

PROPULSION SYSTEM: Bristol-Siddeley Viper turbojet, 2,500 lb. thrust

REMARKS: Operated by Ling-Temco-Vought, Inc. for U. S. Navy os target for surfoce-to-air and oir-to-air missile system on Pocific Missile Ronge; Jindivik can carry voriety of special weapons evaluation equipments ond is equipped with electronic and photographic scoring systems

MQM-15A Target Drone (Navy)

STATUS: Operotional

PRIME CONTRACTOR: Ling-Temco-Vought, Inc.

PERFORMANCE: Moch 2.0 ot 57,-000 ft.

CONFIGURATION: Span, 240 in.; length, 6B4 in.; diameter (body), 72 in.

GUIDANCE: Radio command

PROPULSION SYSTEM: Booster, Aerojet 115,000-lb.-thrust solid-propellont motor; sustainer, one Generol Electric J79 engine with ofterburner

REMARKS: Torget version of the Regulus II missile; limited production; flown as a target for air defense missile systems

MQM-33B Aerial Target (Army, AF) MQM-36A (Navy)

MISSION: Target for gunnery and missile training and evoluation

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura

PERFORMANCE: Max. speed, 220 mph; Stalling speed, 70 mph; rate of climb, 3,350 fpm; service ceiling, 23,000 ft.; endurance, 60 min.

CONFIGURATION: Span, 13B.0 in., with pods 158.5 in.; length, 147.0 in.; height, 31.3 in.; total weight, 326.8 lbs.; with pods 353 lbs.

FLIGHT CONTROL: RPS-1A VHF command control system (MQM-33B); C-24 UHF proportionol command control system with automotic stobilization (MQM-36A)

PROPULSION SYSTEM: 2-cycle, 4-cylinder, flat-opposed, oir-cooled, McCullough Motors engine, driving a fixed-pitch, 44-in.-dia. wooden propeller. Fuel capacity 11.3 gal.

PAYLOAD: For radar appearance augmentation, two wing-tip reflector pods ore added to MQM-33A; standard on MQM-33B and MQM-36A

SUPPORT EQUIPMENT: MQM-33A; ground-launched; MQM-36A, ground-launched only; cotapult, rotory or zero-length launchers used; single porochute 3B-ft.-dio. (MQM-33A) or 32-ft. used for recovery

REMARKS: New model uses 6-cylinder engine for increased performance

MQM-39A Target Drone (Navy)

MQM-61A Target Missile (Army)

MISSION: Provides "out of sight" torget for surface-to-air and oir-to-air missiles

STATUS: Operational

PRIME CONTRACTOR: Beech

PERFORMANCE: Max. speed, 340 mph.; service ceiling, 40,000 ft.; enduronce, 60 min. on station

CONFIGURATION: Span, 155 in.; length, 1B1 in.; diameter (body) 17¾ in.; weight, 635 lbs.

GUIDANCE: Radio command

CONTROL SYSTEM: Beech two-oxis gyroscope outopilot

PROPULSION SYSTEM: One McCullough turbo-superchorged, 125-hp engine with Beech constant speed propellor

SUPPORT EQUIPMENT: Launched from zero-length launcher; porachute-recovered

REMARKS: The two missile targets designated above are identicol in their external configuration, and performance noted above is applicable to both targets

MQM-57A Surveillance Drone (Army)

MISSION: Tactical battlefield surveillance drone capable of performing remote-controlled photo and other sensory missions

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura

PERFORMANCE: Max. speed, 160 mph; stalling speed, 95 mph; rate of climb, 1,500 fpm; service ceiling, 15,000 ft.; endurance, 35 min.

CONFIGURATION: Span, 13B.1 in.; length, 160.9 in.; height, 31.4 in.; empty wt., 354.0 lbs.; useful payload, BB.0 lbs.; total wt., 442.0 lbs.

FLIGHT CONTROL: Modified C-2A proportional-type command control system

TRACKING SYSTEM: AN/DPN-62 beacon (passive reflector pods optional) and an AN/MPQ-29 ground tracking system; night lights for visual tracking

PROPULSION SYSTEM: Modified, four-cylinder, horizontally opposed, two-cycle, air-cooled engine (fuel capacity 5.6 gal.)

PAYLOAD: BB lbs. of photographic or other sensory equipment

SUPPORT EQUIPMENT: Zero-length launcher; single-stage 44-ft. recovery parachute

REMARKS: Only operational surveillance drone in the Army inventory; also being used by British troops

MQM-58A

MISSION: Tactical battlefield surveillance

STATUS: Production

PRIME CONTRACTOR: Aerojet-General

PERFORMANCE: Max. speed, 345 mph; endurance, 45 min.

CONFIGURATION: Span, 156 in.; length, 192 in.; launch wt. (less boosters), 1,103 lbs.

GUIDANCE: System contractor, ITT; type, radio command

PROPULSION SYSTEM: System contractor, Lycoming; type, 1 IMO-360BIB, 225-hp engine; drone also uses 2 JATO units for launch from its zero-length launcher

PAYLOAD: Photographic and other sensory equipment

SUPPORT EQUIPMENT: Launched from Army 2½-ton truck

REMARKS: A modified version of the MQM-58A capable of performing chemical missions

NV-101 Autogyro Drone Aircraft

MISSION: Helicopter target simulation, fixed aerial communications relay, battlefield surveillance, logistics

STATUS: Under development

PRIME CONTRACTOR: Northrop Ventura

PERFORMANCE: Maximum speed, 160 mph; stalling speed, 20 mph; rate of climb, 1,700 fpm; service ceiling, 14,000 ft.; endurance, 60 min.; jump takeoff, zero velocity; land speed, zero (flareout)

CONFIGURATION: Length, 12 ft., 4 in.; height, 3 ft. 9 in.; rotor blade diameter, 24 ft.; weight, 600 lbs. (including 290-lb. payload)

FLIGHT CONTROL: Radio controlled, both in and out of sight

PROPULSION SYSTEM: McCullough 0-100-1 two-cycle 72 hp. engine; preflight rotor spin-up by compressed air or small propellant charge

PAYLOAD: 290 lbs.

SUPPORT EQUIPMENT: Ground launcher with pneumatic rotor blade starter

REMARKS: Has been successfully flight demonstrated more than 10 times at Pt. Mugu, Calif. and White Sands Missile Range N.M.; considered the world's only autogyro drone

NV-104 Advanced Surveillance Drone (Army)

MISSION: Battlefield surveillance drone capable of performing remote-controlled photo and other sensory missions

STATUS: Under military evaluation

PRIME CONTRACTOR: Northrop Ventura

PERFORMANCE: Maximum speed, 250 mph.; altitude, 27,600 ft.; endurance, 210 miles or 45 min.; rate of climb, 3,600 fpm.

CONFIGURATION: Span, 11 ft. 2 in.; length, 14 ft. 9 in.; payload volume, five cubic ft.; payload weight, 150 lbs.

FLIGHT CONTROL: Modified C-2A proportional-type command control system

TRACKING SYSTEM: AN/DPN-62 beacon and AN/MPQ-29 ground tracking system; night lights for visual tracking

PROPULSION SYSTEM: 250 hp T-63 Allison turbojet engine

SUPPORT EQUIPMENT: Zero-length launcher; recovery parachute

REMARKS: An improved version of the Army's only operational surveillance drone, the NV-104 is capable of doubling the present surveillance drone's performance while using 98% of its existing ground support equipment

Redhead/Roadrunner (Army)

MILITARY DESIGNATION: MQM-42A

MISSION: Supersonic target missile

STATUS: Production

PRIME CONTRACTOR: Columbus Div., North American Aviation, Inc.

PERFORMANCE: Operates from Mach 0.9 through Mach 2 and from 300 ft. to 60,000 ft.

CONFIGURATION: Span, 70.12 in.; length, 298.4 in. for supersonic missions and 262.3 in. for subsonic missions; diameter (body) 12 in.; weight (recovery) 434 lbs.

GUIDANCE: System contractor, NAA; type, radio command

PROPULSION SYSTEM: Booster: one 5,500-lb.-thrust Rocketdyne solid motor; sustainer: one Marquardt ramjet engine

SUPPORT EQUIPMENT: Parachute-recoverable

REMARKS: Designed for both low- and high-level missions at either subsonic or supersonic speeds

Rocket Powered Target Drone (Army, Navy)

MILITARY DESIGNATION: AQM-3BA

MISSION: Target for surface-to-air and air-to-air weapon systems

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura

PERFORMANCE: Supersonic version: max. speed, Mach 1.3; service ceiling, 75,000 ft.; endurance 30 min.; subsonic version: mox. speed, Mach 0.9; ceiling, 61,800 ft.; endurance, 30 min.

CONFIGURATION: Span, 60 in.; length 116 in.; height 18 in.; max. weight 301 lbs.

INSTRUMENTATION: Six data channels on the tracking aid RF link for scoring

FLIGHT CONTROL: Automatic with command control override

PROPULSION SYSTEM: Solid-propellant rocket engine with twin thrust nozzles canted 15 degrees outboard in a horizontal plane

SUPPORT EQUIPMENT: Launched from a fighter-type aircraft; recovery by 3-ft. ribbon brake chute and 24-ft.-dia. main chute

REMARKS: Used extensively by the Army for annual service practices of Nike-Hercules and Hawk units around the world

RP-76-200 Rocket Powered Target Aircraft

MISSION: Air-to-air and surface-to-air supersonic target missile; simulates large enemy bomber or missile

STATUS: Under military evaluation

PRIME CONTRACTOR: Northrop Ventura

PERFORMANCE: Speed, Mach 2.25; rate of climb, 10,000 fpm; ceiling 80,000 ft.; duration, 4 min. powered, 30 min. glided control

CONFIGURATION: Span, 4 ft., 4 in.; length, 11 ft.; fuselage diameter, 1 ft.

FLIGHT CONTROL: Air launched from fighter-type aircraft and controlled from the ground by radio

PROPULSION SYSTEM: 200-lb.-thrust solid propellant rocket engine

SUPPORT EQUIPMENT: Recovery parachute

REMARKS: Successfully flight demonstrated at White Sonds Missile Range, N.M.

1025 TJ Target Missile (Army)

MISSION: Provides "out of sight" target for surface-to-air and air-to-air missiles

STATUS: Development

PRIME CONTRACTOR: Beech

PERFORMANCE: Max. speed, in excess of 460 mph; service ceiling, in excess of 40,000 ft.; endurance, 60 min. on-station

CONFIGURATION: Span, 155 in.; length, 204 in.; diameter (body), 17¾ in.; weight, 999 lbs.

GUIDANCE: Radio command

CONTROL SYSTEM: Beech two-axis gyroscope autopilot

PROPULSION SYSTEM: One Continental Model 321-2 turbojet engine (550 lbs. thrust)

SUPPORT EQUIPMENT: Launched from zero-length launcher; parachute-recovered

REMARKS: A product improvement of the MQM-39A and the MQM-61A using a turbojet engine in lieu of the reciprocating engine

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FOREIGN



BLUE STREAK

EUROPE

Aramis (missile)

TYPE: Surfoce-to-oir defense ogoinst low-oltitude oircroft ond possibly missiles

STATUS: Eorly R&D

PRIME CONTRACTOR: Joint project of Dossoult, Motro ond Short Bros. & Horlond

PERFORMANCE: Few detoils ovoilooble; said to be eosily hondled ond designed to fill o "gloring gop" in NATO defenses

REMARKS: Relotionship to Howk low-oltitude ontioircroft mission unknown; hos been presented to severol Europeon countries os NATO project; ossumption is thot Dossoult-Electronique would hondle guidonce, Motro the propulsion, ond Short Bros. the structure

Blue Streak (space booster)

STATUS: Development ond flight test

PRIME CONTRACTOR: Howker Siddeley Dynomics, United Kingdom

CONFIGURATION: Length, 61 ft. 6.3 in.; lift-off weight 207,579 lbs. with propellonts ossuming 193,892 lbs. When empty, shell pressurizotion required ot 5 lbs. sq. in.

PROPULSION: Twin Rolls-Royce LOX/RP1 engines, designated RZ.12, developing combined thrust of 300,000 lbs.; I_{sp} 245 at liftoff developing 150,000 lbs. thrust.

REMARKS: First stoge of Europeon Spoce Vehicle Louncher Development Orgonizotion (referred to os ELDO in this issue) spoce rocket; first lounch June 5, 1964, from Woomero fell slightly short due to premoture cutoff

Coralie (Rocket)

TYPE: Second stoge of ELDO

STATUS: Development

RESPONSIBLE AGENCY: French Loborotoires de Recherches Bolistiques et Aerodynomiques (LRBA), Ministry of Defense

PRIME CONTRACTOR: Nord Aviotion

CONFIGURATION: Length, 19 ft.; diometer, 6.56 ft.; empty wt., 3,850 lbs.; looded wt., 25,300 lbs.; four movoble nozzles, integrol tonkage

PROPULSION: Nitrogen-tetroxide/unsymmetricol dimethylhydrozine generoting 56,000 lbs. thrust ot I_{sp} of 277 sec. (vocuum) for 97 seconds burning time; UDMH coats nozzles for cooling; propellants olso used for gos generotor

PERFORMANCE: Sloted for first ELDO vehicle, to put third stoge (7,260 lbs.) ond poylood (1,000 kg) into orbit; olso to be used by Fronce os first stoge, sounding rocket, under nome Coro; switch to hydrogen/oxygen propellants considered

REMARKS: Test-fired in Februory successfully ot Vernon, Fronce; on schedule with six future flight tests slated from ground sites using modified hordwore to get oerodynomic ond structurol doto; flight tests sloted ot Hommoguir, Algerio; two stoges per month to be built from June, 1965, to Februory, 1966

ELDO Third Stage (booster stage)

TYPE: ELDO sotellite booster

STATUS: Development

PRIME CONTRACTOR: Entwicklungsring Nord (ERNO) ond Boelkow-Entwicklungen KG, West Germany

MISSION: 1.2 tons in low orbit; 400 lbs. in high orbit

CONFIGURATION: Looded wt., about 8,000 lbs.; empty weight, about 1,100 lbs.

SIZE: Diameter, 6½ ft.; length, 11.2 ft.

GUIDANCE: Rodio-inertiol, two vernier rockets

TELEMETRY: Will corry on-boord equipment

PROPULSION: Hypergolic; oerozine ond N_2O_4; moin engine, 5,000 lbs. thrust; vernier 50 kp ond 30 kp

REMARKS: ASAT (Arbeitsgemeinschoft Sotellitentroger) is Germon Sotellite Corrier Advisory Group responsible for third-stoge development work for the ELDO progrom. Total ASAT development cost estimoted ot $24 million; expect to flight-test vehicle with French Coralie in 1965 in Sohoro

Ophos IE (booster stage)

TYPE: Proposed odvonced ELDO third stage

STATUS: Reseorch ond development

PRIME CONTRACTOR: Boelkow-Entwicklungen KG, West Germony

PERFORMANCE: Poylood, 1,320 lbs.

CONFIGURATION: Gross design weight, 8,600 lbs.; empty, 1,150 lbs.; rodiol thrust chamber ond E-D nozzle designed for 4,000 kp thrust; two verniers ot 40 kp thrust in vocuum. High-energy propellonts F_2/H_2; length, 142 in.; diometer, 79 in.

REMARKS: Moinly compony-finonced research with moderote government reseorch funds from High Energy Rocket Engine Notionol Development Project. Tests using LOX ond subcooled H_2 olreody conducted

AUSTRALIA

HAD (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment, Salisbury

PERFORMANCE: 3,200 mph at second-stage burnout; 20-lb. payload to 80 mi.

CONFIGURATION: Two-stage solid; length, 19½ ft.; second-stage diameter 5 in.; launch weight, 640 lbs., weight of second stage, 115 lbs.

CODE MEANING: HAD=High-Altitude Density

HAT (sounding rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment, Salisbury

PERFORMANCE: Carries 20-lb. payload ta 40 mi.

CONFIGURATION: Length, 17½ ft.; secand-stage diameter, 5 in., launch weight, 540 lbs., second-stage weight, 115 lbs.

CODE MEANING: HAT=High-Altitude Testing

REMARKS: Develaped for use in development af a drap sande

Ikara (antisubmarine)

STATUS: R&D

PRIME CONTRACTOR: Weapons Research Establishment

REMARKS: No data released beyond fact it may be a tarpeda carrier. Australian sources claim U.S. has invested $4 million in research

Jabiru (research rocket)

STATUS: Operational

PRIME CONTRACTOR: Weapons Research Establishment in Australia jointly with Royal Aircraft Establishment in U.K.

CONFIGURATION: Length, 39 ft.; three-stage solid; first-stage diameter, 1.43 ft.; span, 6.33 ft.; launch weight, 3,700 lbs.

GUIDANCE: Nane

PAYLOAD: 55-lb. instrumentatian head

PERFORMANCE: 6,400 mph at third-stage burnaut, up to Mach 10 in level flight between 80,000 and 100,000 ft.

REMARKS: Knawn in U.K. as Jaguar

MALKARA



Long Tom (sounding rocket)

STATUS: Operatianal

PRIME CONTRACTOR: Weapans Research Establishment, Salisbury

PERFORMANCE: 30-lb. paylaad to aver 100 mi. ar 180-lb. payload to 68 mi.; 3,500 mph at secand-stage burnaut

CONFIGURATION: Two-stage solid; first stage cluster of three rackets; second-stage diameter 9.2 in.; launch weight, 2,000 lbs.; length, 27 ft.

REMARKS: Woamera Rocket Range instrumentation test vehicle far ground and airborne instrumentation. Evolved inta "workhorse" capability; also used to measure micrometearite prevalence and for high-altitude photagraphy

Malkara (antitank)

STATUS: Operatianal

PRIME CONTRACTOR: Government Aircraft Factaries (Australia)

PERFORMANCE: Range, 2 mi.; has received extensive anti-bunker and jungle evaluation

CONFIGURATION: Length, 6½ ft.; weight, abaut 200 lbs., span, 2 ft. 8 in.

GUIDANCE: Wire

EUROPEAN AGENT: British Aircraft Corporation handles Europeen expart sales

PROPULSION: Two-stage salid

CANADA

Alouette (satellite)

STATUS: R&D

PRIME CONTRACTOR: Canadian Defense Research Telecommunications Establishment

PERFORMANCE: First in planned series successfully orbited Sept. 28, 1962, by Thor-Agena B fram Paint Arguella, Calif.; still transmitting ionasphere data

CONFIGURATION: Nearly oval; 42-in. dia.; 320 lbs.; 6,500 salar cells; ane 150-ft.-long antenna, one 75-ft.-long antenna

REMARKS: First nan-Soviet, nan-U. S. satellite in space; all-Canadian fabrication; Alouette B will be launched in second quarter of 1965 as part of NASA's continuing joint internatianal pragram with Canada

Black Brant (sounding rockets)

STATUS: Family of four sounding rockets; BB-II and BB-III operational; BB-IV and BB-V in develapment tests

PRIME CONTRACTOR: Canadian Bristol Aerojet Ltd., Winnipeg; first model, Black Brant I, product of Canadian Armament Research and Development Establishment (CARDE); BB-II Canadair, Ltd. (Montreal) & Canadian Bristol Aerojet

PERFORMANCE: BB-II, 17-in.-dia; single-stage, 150 lbs. to 125 miles altitude; BB-III, 10-in.-dia., single-stage, 50 lbs. to 90 mi., 40 lbs. to 110 mi. (June 1964); BB-IV, 17-in.-dia. first stage, 10-in.-dia. second stage, 40 lbs. to 600 mi. alt.; BB-V, 17-in.-dia., single stage, 150 lbs. to 240 mi. altitude

CHARACTERISTICS: Non recoverable in current designs but can be modified, baom launched, all fin stabilized; all solid propelled units using CARDE and now also Aerajet-General formulations

FLIGHTS: Primarily fram Churchill Research Rocket Range, Manitoba, althaugh some of the family documented for U. S. ranges such as Wallops and Pt. Mugu (PMR); developmental BB-IV launched twice from Churchill ta date; stage separation problems; next launches in develapment program scheduled for fall 1964; BB-V slated for first development launch in late 1964

REMARKS: Black Brant series gaining acceptance in Canadian universities far upper atmosphere research efforts; current effort ta market warld-wide

EGYPT

Star (satellite)

TYPE: Electramagnetic research

STATUS: R&D

REMARKS: Details unknawn, but the pragram is under direction af Dr. Walfgang Pilz; the Heliapalis center near Cairo is develaping a launch vehicle based an Al Ared; and the schedule is slipping, with July, 1964, launch naw expected "later this year;" a naminal 300-mi. arbit is expected for the first versian and a larger fallow-an project has been reported

Al Ared (Pioneer) (missile)

TYPE: Surface-to-surface
STATUS: Development

CONFIGURATION: Twa-stage, liquid prapellants
PERFORMANCE: Range, 600 mi.
REMARKS: Reportedly suffering fram unreliable guidance system, as are ather UAR rockets

Al Kaher (Conqueror) (missile)

TYPE: Surface-ta-surface
STATUS: Productian

PERFORMANCE: Range, 372.6 mi.
CONFIGURATION: Single-stage, liquid-fueled
REMARKS: Twenty missiles in July 23, 1962, parade in Caira. First public annauncement af launching made an July 21, 1962

Al Zafer (Victorious) (missile)

TYPE: Surface-ta-surface
STATUS: Praduction

PERFORMANCE: Range, 235.9 mi.
CONFIGURATION: Single-stage, liquid-fueled
REMARKS: First public test launching July 21, 1962; abaut 300 Al Zafer and Al Kaher missiles have repartedly been manufactured



AS-30

FRANCE

Agate (rocket)

TYPE: IR8M reesarch racket; farms 1st stage af Rubis
STATUS: Operatianal
RESPONSIBLE AGENCY: SERE8 (Saciété pour l'Etude et la Réalisatian d'Engins Balistiques)
CONTRACTORS: Nard-Aviatian, SEPR, Sud-Aviatian
PERFORMANCE: Has reached 30-mi. altitude with half-tan paylaad
CONFIGURATION: Length, 27.8 ft.; diameter, 2.6 ft.; single stage; liftaff weight, aver 3 tans
PROPULSION: Salid, 4,180 lbs., 48,400 lbs. thrust for 27 sec.
GUIDANCE: Nane
REMARKS: SEREB, technical IRBM agency under Délégatian Ministérielle de l'Armement, is campased af representatian af Sud-Aviatian, Nard Aviatian, ONERA, Dassault, SNECMA, Matra and SEPR; in Preciaus Stanes Series; athers in series, Diamant, Emeraude, Rubis, Saphir and Tapaze

AS-20 (missile)

TYPE: Air-ta-surface
STATUS: Operatianal
PRIME CONTRACTOR: Nard Aviatian
CONFIGURATION: Length, 8.5 ft.; diameter, 9.84 in.; span, 2.5 ft.; weight, 293 lbs. Salid booster and sustainer
GUIDANCE: Radia cantral, visual alignment

AS-30 (missile)

TYPE: Air-ta-surface
STATUS: Operatianal
PRIME CONTRACTOR: Nard Aviatian
CONFIGURATION: Length, 12.5 ft.; diameter, 13.5 in.; span, 3.3 ft.; weight, 1,100 lbs. Salid baaster and sustainer
GUIDANCE: Multi-channel HF transmitter
REMARKS: Chasen by Britain ta arm its Canberra bambers far strike missians

Bélier (sounding rocket)

STATUS: Operatianal
PRIME CONTRACTOR: Sud-Aviatian
PERFORMANCE: 4,070 lbs. thrust 22 sec.; I_{sp}, 203 sec.; max. alt., 50 miles; max. vel. 4,330 ft./sec. Typical paylaad, 66 lbs.
CONFIGURATION: Single salid baaster. Jericha "epictete" prapellant grain (457 lbs.). Length, 13.1 ft.; all-up weight, 689 lbs. Fins hause telemetry gear and respander antennas
INSTRUMENTATION: CNET
REMARKS: Ta be built under license in India

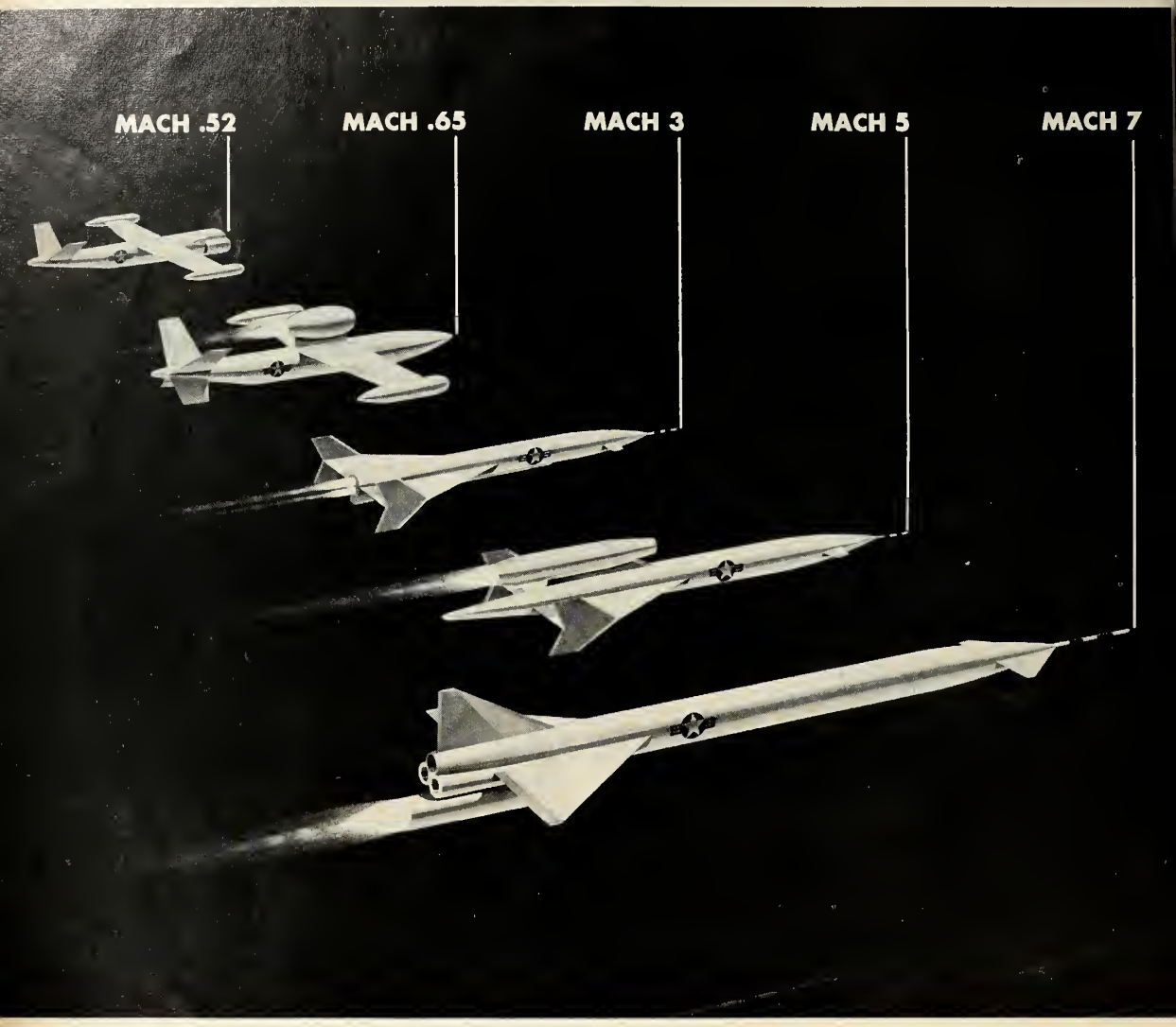
Bérénice (rocket)

TYPE: IRBM Research
STATUS: Operatianal
RESPONSIBLE AGENCY: Office Natianal d'Etudes et de Recherches Aéraspatiales (ONERA) far SEREB (IR8M Agency)
PERFORMANCE: Mach 12 re-entry when 3rd and 4th stages fired in descent
CONFIGURATION: Faur salid stages. Length, 42 ft.; diameter: 1st stage, 22 in., 4th stage, 9 in.; all-up weight, 7,400 lbs.
GUIDANCE: First stage has three axis autapilat transmitting cammand signals ta faur salid baasters attached ta first stage. Attitudes af 3rd and 4th stages cantralled before re-entry
INSTRUMENTATION: ONERA telemetering equipment
PROPULSION: Faur salid stages and faur small "guidance" salid rackets. All but 4th stage by SEPR
REMARKS: Optical graund equipment af the French Navy Launching Center (CERES) an Levant Island in Mediterranean. Alsa, ONERA and CERES electramagnetic trajectagraphy

Centaure (sounding rocket)

STATUS: Operatianal
PRIME CONTRACTOR: Sud-Aviatian
PERFORMANCE: Thrust: 1st stage, 8,800 lbs. 4 sec.; 2nd stage, 4,070 lbs. 22 sec.; I_{sp}: 1st, 200; 2nd, 203; typical paylaads, 100 lbs. with max. alt., 110 miles; max. vel., 5,834 ft./sec.
CONFIGURATION: Length, 19.5 ft. Diameter: 1st, 9.8 in.; 2nd, 11 in.; all-up weight, 1,080 lbs. max. Two salid stages, first-stage prapellant grain is 206.8 lbs. Venus "Plastalite." Secand stage is madified Bélier
REMARKS: First-stage diameter smaller than secand stage. Ta be built under license in India; France will pravide faur far Indian use befarehand; five ta be fired in Iceland

Beech "Imaginuity" in missile systems



Now, what's beyond Mach 7?

Beech "Imaginuity" in missile target systems is finding out

How fast will tomorrow's missile target systems need to be? The answer: just as fast as the speediest enemy hardware—jets or missiles—that Free World gunners may have to shoot at. What will it take to provide these advanced missile systems . . . to turn "impossible" requirements into solid reality by the time they are needed?

Beech "Imaginuity" is already at work, seeking—and finding—the answers. The Beech AQM-37A (KD2B-1), now in line production for the U. S. Navy, is capable today of speeds above Mach 3 and can be flown at altitudes of 90,000 feet. It gives today's most advanced weapon systems a realistic challenge to their capabilities.

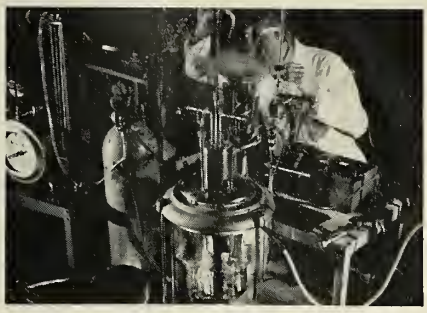
But, just as important, Beech has already designed a family of missile target systems for a wide variety of defense training missions, ranging from Mach .52 to Mach 7—and is now reaching out beyond that.

This kind of probing into the future, plus Beech "Imaginuity" in design, development, fabrication and testing has given Beech a head start on development of the advanced missile systems that will be needed for tomorrow's training and air defense requirements.

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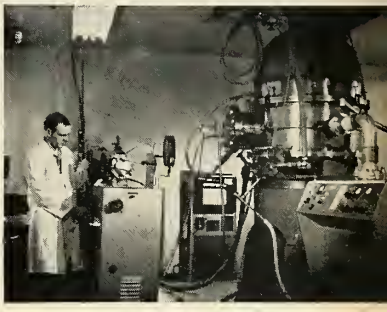
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Missile Target Systems



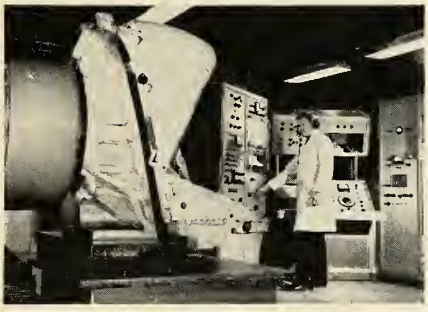
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D Series (satellite)

STATUS: R&D

PROGRAM SPONSOR: CNES

TECHNICAL ADMINISTRATOR: Centre d'Enseignement et de Recherches Médicales Aéronautiques

MISSION: Mk 1: Capsule carrying cat in suborbital flight, 1963. Mk 2: Capsule carrying monkey using Diamant booster, 1965

REMARKS: Follow-on bioscientific program directed by CERMA

D-1 (satellite)

STATUS: R&D

PROGRAM SPONSOR: CNES

CONTRACTORS: Matra, frame; Dassault, electronics; C.N.R.S., solar panels; S.A.T., assembly of power-generating system

MISSION: First all-French satellite to be orbited by Diamant rocket in late 1965; designed to check out all launch techniques and to get experience

CONFIGURATION: 77 lbs., of which 36 lbs. will be instrumentation; orbit planned is 1,800-mi. apogee and 375-mi. perigee; initial purpose is to check rotation of final stage and payload, measure separation velocity, and similar launch characteristics; 4 solar panels will be extended in orbit; shape is roughly a cylinder 19.4 in. in diam., and 7.85 in. high; four telemetry antennas are on upper face, transmitting on 150 mc; dipole on lower face transmits on 400 mc; spin-stabilized at 30 rpm; orbit inclination will be 30°; launch from Hammaguir, Algeria, with period of about two hours; life expectancy is 3 months

REMARKS: D-2 expected to be quite similar in appearance and mission; Budget for entire F and D series of satellites in 1964 is $6.5 million

D-3 (satellite)

STATUS: R&D

PROGRAM SPONSOR: CNES

CONFIGURATION: Weight, 75 lbs.

MISSIONS: 1) Modified satellite with advanced radiation-measurement instrumentation and telemetry for powered booster performance and attitude; 2) Advanced J. E. Blamont instrumentation; hydrogen measurements; 3) Magnetic and laser experiments; 4) Solar-oriented experiments

REMARKS: One of several payloads planned for Diamant booster

Dauphin (sounding rocket)

STATUS: R&D

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Max. altitude, (220-lb. payload) 85 mi., (650-lb. payload) 50 mi.

CONFIGURATION: Single solid stage; length, 16.7 ft.; diameter, 2.8 ft.

Diamant (space rocket)

STATUS: Development

RESPONSIBLE AGENCY: Centre National d'Etudes Spatiales and Délégation Ministérielle de l'Armement

CONTRACTORS: Nord-Aviation, 1st & 2nd stages; Sud-Aviation, 3rd stage

TECHNICAL ADMINISTRATION: SEREB

CONFIGURATION: Mk 1: Liquid first stage, 32.8 ft. in length has all-up weight of 31,240 lbs. with total thrust of 28 tons. Spent weight, 3,740 lbs. Second stage: Modified *Topaze* (See *Topaze* details). Third stage: Glass fiber-wound Sud-Aviation design. Solid fuel. 26 in., 1,430-lb. polyurethane grain burns 47 sec. Mk 2 verson may have 45.9-in. diameter solid-grain first-stage motor developing up to 40 tons, compared to Mk 1 first-stage thrust of 28 tons. Service des Poudres has already developed and tested grains weighing 25 tons.

REMARKS: First satellite attempt scheduled for 1965. In Precious Stones series. Glass fiber 3rd stage tested in March, 1964, for first time at simulated altitude; budget for 1964 is $3.2 million



ENTAC

Dragon (sounding rocket)

STATUS: Development

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust: 1st stage, 24,000 lbs. 16.5 sec.; 2nd., 4,070 lbs. 22 sec.; altitude, 292 mi.; payload, 66 lbs.

CONFIGURATION: Length, 23 ft.; diameter, 1st 2.8 ft.; 2nd 11 in.; weight, 2,926 lbs.

INSTRUMENTATION: CNET

PROPELLANT: La Pouderie de St.-Médard; solid

REMARKS: At least four launched to date

Emeraude (space rocket)

STATUS: R&D

PRIME CONTRACTOR: SEREB

CHARACTERISTICS: Liquid first stage, dummy second and third stage. Will test Diamant first-stage propulsion plus design and airframe structure for Diamant

REMARKS: In Precious Stones series

Entac (missile)

TYPE: Antitank

REMARKS: Prime contractor DEFA; first-line European producer, Atelier de construction de Puteau; producer for U.S. Army, Nard Aviation. See U.S. surface-to-surface missiles

Eridan (sounding rocket)

STATUS: R&D

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust, each stage 22,000 lbs. for 15 sec.

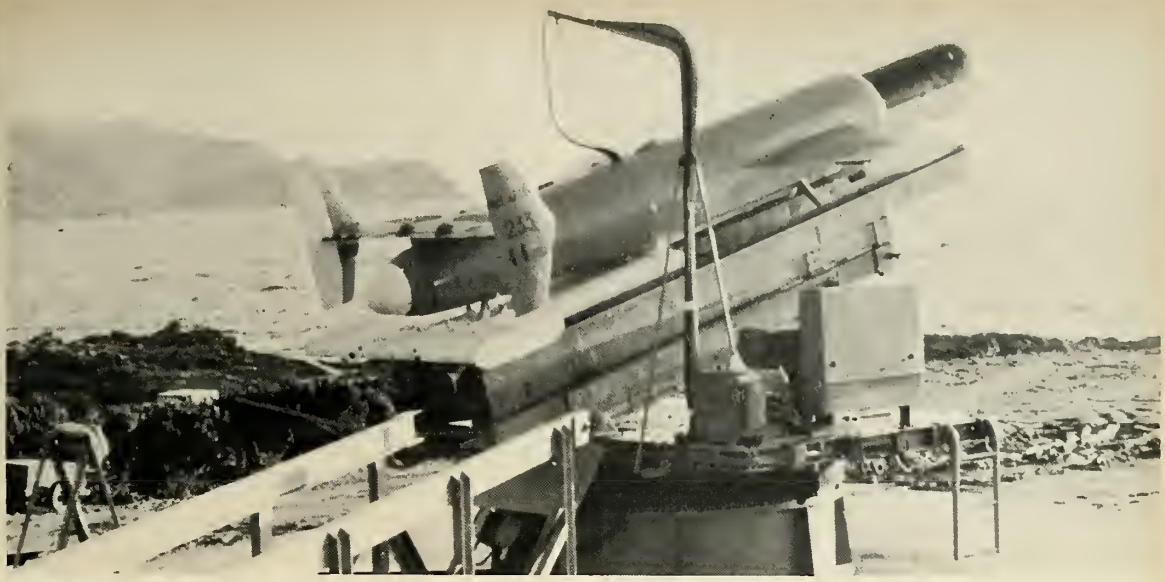
CONFIGURATION: Two solid stages. Length, 27.2 ft.; weight, 4,466 lbs.

Geneviève (satellite)

STATUS: R&D

PRIME CONTRACTOR: SNECMA (Société Nationale d'Etude et de Construction de Moteurs d'Aviation)

REMARKS: France's first telecommunications satellite proposed for synchronous orbit in TV relay system using nuclear power source. SNECMA proposes electro-thermal arc for propulsion in first phase and instrumentation power in subsequent phases



MALAFON

Iris (postal rocket)

TYPE: Mail carrier

STATUS: Development

PRIME CONTRACTOR: Matra

PERFORMANCE: Cruise altitude, 72,000 ft.; speed, over Mach 2; range, 435 mi.; mission time, 20 mins.; payload, 66 lbs.

CONFIGURATION: Canard shape; 2 ramjets; vertically launched; rator extends on descent and allows controlled landing like that of a helicopter with telescoping blades; liftoff wt., 2,425 lbs.

REMARKS: Landing system developed by Société Gyrovions Dorand

Latècoère 110 (rocket)

TYPE: Research Vehicle

STATUS: R&D

PRIME CONTRACTOR: Société Industrielle d'Aviation Latécoère

REMARKS: Postal experimental vehicle developed for Ministry of Mail and Telecommunications (Postes et Télécommunications)

Malafon (missile)

TYPE: ASW

STATUS: Operational

MISSILE PRIME CONTRACTOR: Société Latécoère

PERFORMANCE: Range, over 14,000 yds. Velocity, 754.4 ft./sec.

CONFIGURATION: Twin solid boosters. Carries ASW homing torpedo. Overall length, 19.7 ft.; all-up weight, 3,179 lbs.

GUIDANCE: Radio control

TECHNICAL ADMINISTRATON: Service Technique des Constructions et Armes Navales

REMARKS: First sea test in 1962. Will arm frigates now under construction and on T.47 class escort vessel

Masurca (missile)

TYPE: Ship-to-air

STATUS: Development

PERFORMANCE: Mk 2 Mod 2: 20 mi.; Mk 2 mod 3: 25 mi. Velocity: Over 2,500 ft./sec.

CONFIGURATION: Two stages. Length, 27.9 ft.; weight, 3,828 lbs. Solid booster and sustainer

GUIDANCE: Mk 2 Mod 2: Beam rider. Mk 2 Mod 3: Beam rider and semiactive homing

RADAR/RADIO CONTROL: Société Française Thomson-Houston

FIRE CONTROL: I.B.M. France

TECHNICAL ADMINISTRATON: Service Technique des Constructions et Armes Navales

LAUNCHING AND HANDLING: Etablissement Industriel de la Marine Nationale à Ruelle

REMARKS: Mk 1 in production and destined for early available missile frigates. Mk 2 will arm Duquesne and Suffern class frigates, helicopter carrier La Résalue and future frigates

Matra R. 511 (missile)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: Société des Engins MATRA

PERFORMANCE: Range, 9,800 to 59,000 ft.

CONFIGURATION: Length, 10.14 ft.; diameter, 8.5 inches.; span, 3.3 ft.; weight, 396 lbs.; single-plane wings and dorsal rear fin, with vertical stabilizers at wing-tips

GUIDANCE: Compagnie Française Thomson-Houston; system, semi-active radar

PROPULSION: Solid fuel by Hotchkiss-Brandt

Matra R. 530 (missile)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: Société des Engins MATRA

PERFORMANCE: Sea level to 82,000 ft. operating altitude; range 13 mi.

CONFIGURATION: Length, 10.5 ft.; diameter, 8.5 in.; weight, 429 lbs.; fin span, 36.1 in.; two sets of cruciform fins

GUIDANCE: Version A: Semiactive radar homing system by G. A. M. Dassault. Version B: Infrared homing by Société Anonyme de Télécommunications

PROPULSON: Solid rocket with boost/sustain phases; 18,560 lbs. total impulse

OTHER SYSTEM SUBCONTRACTORS: Hotchkiss-Brandt, Compagnie Générale de Télégraphie Sans Fil, and Télécommunications Radioélectriques et Téléphoniques

REMARKS: Witnesses to flight tests described R. 530 as "Queen" of air-launched missile armament. Trials reported highly successful. Ordered by Australia to equip its Mirage III fighters, and will be used on French Navy "Crusaders"

Phaeton (satellite)

STATUS: R&D

PRIME CONTRACTOR: SEPR

PERFORMANCE: Design goal: thermic-electrical propulsion: 20 to 40 grams

CONFIGURATION: Length from boiler (top) to reservoir tank (bottom), 16.4 ft.; diameter of parabolic reflector, 15.7 ft.; all-up weight options vary from 660 lbs. to 2,420 lbs. Auxiliary power 2.25 kw. Orbiting propulsion system would utilize liquid hydrogen reaching 3000°K. Payload instrumentation and fuel required for mission provide tradeoff parameters for available 250 lbs.

PROGRAM SPONSOR: CNET



PHAETON

Rubis (rocket)

TYPE: Development of Diamant satellite launch vehicle; scientific experiments

STATUS: Development

RESPONSIBLE AGENCY: Societe pour l'Etude et la Realisation d'Engins Balistiques (SEREB)

CONTRACTORS: First stage, Nord-Aviation, Sud-Aviation, SEPR; second stage, Sud-Aviation for structure, Matra for payload capsule

CONFIGURATION: Overall length, 31.7 ft.; diameters, 2.6 ft. and 2.1 ft.; fin-stabilized; steel first stage, glass fiber second stage; second stage empty wt. 1,606 lbs.; loaded wt., 3,036 lbs.; first stage empty wt., 1,485 lbs.; loaded wt., 5,665 lbs.; total launch wt., 7,470 lbs.

PERFORMANCE: Capable of lifting 110 lb. payload to 1,250 mi. altitude as probe; principal function is to serve as development vehicle for Diamant satellite launcher

PROPULSION: Solid propellants; first stage uses 4,180 lbs.; second stage uses 1,430 lbs.; first stage burns 27 seconds with 48,400 lbs. thrust; second stage burns 46 seconds with 11,000 lbs. thrust at specific impulse of 275 seconds

GUIDANCE: Ramp-launched with corrections included in angle and azimuth arm

REMARKS: Serving as test vehicle for development of Diamant vehicle; second stage of Rubis is similar to third stage of Diamant; first Rubis launched June 10 at Hammaguir to altitude of 1,118 mi.

Saphir (space rocket)

STATUS: R&D

PRIME CONTRACTOR: SEREB

CHARACTERISTICS: Liquid first stage; solid second stage; dummy third stage. Follows Emeraude in proving Diamant design

GUIDANCE: Probably modified Topaze system

REMARKS: In Precious Stones series

SS-10 (missile)

TYPE: Antitank

REMARKS: See U. S. surface-to-surface missiles

SS-11 (missile)

TYPE: Antitank

REMARKS: See U. S. surface-to-surface missiles

SS-12; AS-12 (missile)

TYPE: SS, Antitank; AS, Air-to-surface

STATUS: R&D, evaluation

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Surface launch, max. range, 6,550 yds.; air launch, max. range, 11,000 yds.; spin-stabilized

CONFIGURATION: Length, 63 in.; diameter, 7.1 in.; 165 lbs.

Stataltex (rocket)

TYPE: Experimental vehicle

STATUS: Operational

PRIME CONTRACTOR: ONERA

PERFORMANCE: Mach 5 plus in early 1961 trials. Sees continuous use for ram-jet propulsion tests. Reaches 125,000 ft. at lower Mach numbers. Baoster gives Mach 3.2, sustainer ignites at 23,000 ft.

CONFIGURATION: Length, 17 ft.; max. diameter, 16½ in.

GUIDANCE: None, but carries ONERA telemetering instrumentation

PROPULSION: Ramjet sustainer. Solid SEPR booster

SUPPORT EQUIPMENT: French Navy range optical units at CERES Missile Range off Riviera coast on Levant Island

REMARKS: ONERA and Nord Aviation have agreement for cooperation in ram-jet development field, as do Nord and Rohr aircraft in the U. S.

Topaze (rocket)

TYPE: IRBM research vehicle and Diamant second-stage prototype

STATUS: Flight testing

PRIME CONTRACTOR: SEREB

CHARACTERISTICS: First stage: Nord-designed rocket plant using four SEPR motors and power pack by Air-Equipement. This stage constitutes booster. Second stage: Nord-designed rocket plant. 30-in. polyurethane grain weights 5,005 lbs.; burns 42 sec.; up to 30,000 lbs. thrust in vacuum. Flight control by swivel nozzles. Autopilot guidance by S.A.G.E.M. Interstage and equipment section by Sud Aviation SEFI automatic check-out system

REMARKS: Diamant will use modified Topaze as second stage. Prototype Diamant third stage was given compatibility flight test with Topaze and recovered by parachute in test at Hammaguir. Propellant grain manufactured by La Pouderie de St.-Médard. In Precious Stones series

Vega (rocket)

STATUS: Experimental vehicle

PRIME CONTRACTOR: Nord Aviation. Special arrangement with ONERA (See Stataltex.)

PERFORMANCE: Has reached Mach 4. Operating altitude, 65-110,000 ft.; solid booster, 5 sec.; Booster, Mach 2

CONFIGURATION: Length, 32.5 ft.; diameter of booster, 22 in.; sustainer, 26 in. Ramjet second stage

GUIDANCE: Autopilot

PROPULSION: Booster, Vesuve-type solid propellant

REMARKS: Nord conducts lead ramjet R & D efforts for Direction Technique et Industrielle de l'Aéronautique

Véronique 61 (sounding rocket)

TYPE: Research prabe

STATUS: Develapment

PRIME CONTRACTOR: Laboratoire de Recherches Balistiques et Aerodynamiques pour l'Armament

PERFORMANCE: Reached 161.5 mi. altitude in first firings

CONFIGURATION: Single stage, liquid propellant

REMARKS: Designed to replace Véronique probe and gets 62 mi. higher; first flights were in June; development is through Ministry af Defense and firings are at Hammaguir, Algeria

Vesta (sounding rocket)

STATUS: R&D flight test

PRIME CONTRACTOR: D.E.F.A., Laboratoire de Recherches Balistiques et Aérodynamiques (Vernan)

PERFORMANCE: 1,100-lb. payload to 236 mi. Five times early Véronique payload area

CONFIGURATION: Length, 32.5 ft.; diameter, 32.8 in.; all-up weight, 11,979 lbs.; total surface thrust, 31,680 lbs.; I_{sp} at surface, 193 sec., in vacuum, 238 sec.

REMARKS: Vesta is higher performer than Véronique 61 or 61A; to be used for carrying monkeys into space for biomedical research on motar nerves under Zero-g conditians

GERMANY

Cobra 810 (missile)

TYPE: Antitank

STATUS: Operational with West German Army; Denmark and Italy have ordered

PRIME CONTRACTOR: Boelkow-Entwicklungen KG

PERFORMANCE: Range, 437 to 1,750 yds. at about 190 mph

CONFIGURATION: Length, 38 in.; span, 3.9 in.; launch weight 23.3 lbs.

GUIDANCE: Wire-guided, rolling stability acceleration guidance

REMARKS: Top feature: ease of one-man handling

Dornier Type 122 (sounding rocket)

STATUS: Evaluation

PRIME CONTRACTOR: Dornier-System G.m.b.H.

PERFORMANCE: 11-lb. payload to 54-mi. altitude

CONFIGURATION: Rogallo wings of 15-ft. span; length overall, about 25 ft.

REMARKS: Dornier Rogallo wings are innovation in sounding rockets and enable the Type 122 to be recovered with great precision



BLOODHOUND

GREAT BRITAIN

Bloodhound (missile)

TYPE: Surface-to-air

STATUS: Mk 1 phasing out with RAF; Mk 2 operational status imminent

PRIME CONTRACTOR: British Aircraft Corp. (BAC) with Ferranti Ltd.

PERFORMANCE: Mk 1, high-altitude, long-range; Mk 2, same with faster reaction and low-altitude capability and air transportability

CONFIGURATION: Mk 1, four solid boosters with two ramjet sustainers

GUIDANCE: Radar-guided with terminal homing

OTHER CONTRACTORS: Supporting BAC and Ferranti are Associated Electrical Industries Limited, Bristol Siddeley Engines Limited, Electrical and Musical Industries Limited, and M.L. Aviation Limited

REMARKS: Mk 1 units in U.K., Sweden and Australia. Switzerland has adopted Mk 2 system for air defense. Mk 2 deployed to Malaysia

Blue Steel (missile)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Hawker Siddeley Dynamics

CONFIGURATION: Length, 35 ft.; max. diameter 4 ft. 2¼ in.; span, 13 ft.

GUIDANCE: Autopilot and inertial navigator. Elliott Bros. Ltd.

PROPULSION: H.T.P. and Kerosene Stentor engine by Bristol Siddeley Engines Ltd.

REMARKS: Operational on Vulcan and Victor bombers, with all aircraft slated for fitting to be equipped this year

Firestreak (missile)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: Hawker Siddeley Dynamics

PERFORMANCE: 85% success in acceptance trials

GUIDANCE: Infrared-homing, radar-slaving

Jaguar (rocket)

TYPE: Research

STATUS: Operational

PRIME CONTRACTOR: Royal Aircraft Establishment jointly with Weapons Research Establishment in Australia

REMARKS: For details, see Jabiru racket, Australia section; 17 have been fired by British at Woomera

Red Top (missile)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: Hawker Siddeley Dynamics; Hughes, guidance

PERFORMANCE: Better range, speed, altitude and attack angle than Firestreak

CONFIGURATION: Length, 137.5 in.; dia., 8.75 in.; span, 35.7 in.; retains Firestreak design for four fixed wings and four moving rear control surfaces; also solid fuel

GUIDANCE: Infrared-homing, automatic firing upon pilot's committal release

REMARKS: Has printed circuit boards. Automatic soldering used in production; arms Lightning and Vixen aircraft, deliveries beginning this year

Seacat (missile)

TYPE: Short-range ship-to-air defense

STATUS: Operational with two navies; ordered by five more

PRIME CONTRACTOR: Short Brothers & Harland Ltd.

PERFORMANCE: Subsonic "in-fighter" of extremely simple design; has lowest minimum range of any surface-to-air missile

CONFIGURATION: Length, 58 in.; 7.5 in. dia.; 4 swept-back 60-deg. movable fins forward & 4 fixed fins aft

GUIDANCE: Radio command/optically coordinated; bulk of system remains on ship; flares on fins give visual aid for operator tracking

PROPULSION: Imperial Metal Industries solid rocket with boost/sustainer phases using integral steel case

LAUNCHER: Rose Brothers

DEVELOPMENT: Mk 2 in R&D

REMARKS: New Zealand, West Germany, Chile, The Netherlands, Australia and Sweden already ordered system, others interested. Dutch fire control by Signaalapparaten used with missile on Swedish ship Sadermanland. Entered service in record time 5 years after development began. Land-based version called Tigercat, also usable against surface targets

Sea Dart (CF. 299) (missile)

TYPE: Ship-to-air

STATUS: R&D

PRIME CONTRACTOR: Hawker Siddley Dynamics

SUBCONTRACTORS: Associated Electrical Industries Ltd., EMI Electronics Ltd., Ferranti Ltd., G.E.C. (Electronics) Limited, Sperry Gyroscope Company Limited, Vickers-Armstrongs (Engineers) Ltd.

REMARKS: Intended for use on small vessels. Would provide frigates with firepower comparable to 5,000-ton guided missile ships now in service and is expected to be as effective as large missiles like Seaslug, while occupying much less space

Seaslug (missile)

TYPE: Ship-to-air
STATUS: Mk 1 Operational, Mk 2 R&D
PRIME CONTRACTOR: Hawker Siddeley Dynamics (Whitworth Gloster Aircraft Ltd.)
PERFORMANCE: Long-range ship's defense; Mk 1 on County-class guided missile ships; Mk 2 to be retrofitted
CONFIGURATION: Mk 1: Length, 19.8 ft.; span 4.8 ft.; dia., 16.1 in.; faur solid boosters and solid sustainer
GUIDANCE: Beam-riding, General Electric Co., Ltd.
FLIGHT CONTROLS: Sperry Gyroscape Ca., Ltd.

Swingfire (missile)

TYPE: Antitank
STATUS: R&D
PRIME CONTRACTOR: British Aircraft Corporation
REMARKS: Described as second-generation antitank missile. BAC and Nard-Aviation, leading antitank missile producer, have technical arrangement which possibly affects Swingfire develapment

Thunderbird (missile)

TYPE: Surface-to-air
STATUS: Mk 1, operational, Army; Mk 2, develapment
PRIME CONTRACTOR: British Aircraft Corporation (English Electric)
CONFIGURATION: Mk 1—length, 20.8 ft.; dia., 21 in.; span, 64 in.; Mk 2—length, 20.9 ft.; ather principal dimensians same; controlled by four cruciform rear fins; stabilization through four forward cruciform fins
PROPULSION: Solid sustainer, with four booster strap-on solid motors
GUIDANCE: Mk 1—Pulse radar semi-active homing; Mk 2—CW radar semi-active haming
REMARKS: Mk 2 designed to be mare automatic, have longer range; Mk 1 deployed in Aden

Vigilant (missile)

TYPE: Antitank
STATUS: Operational
PRIME CONTRACTOR: BAC (English Electric Aviation Ltd.)
PERFORMANCE: Range: 200 to 1,800 yds., penetrates 22-in. armor plate; speed, 350 mph
CONFIGURATION: Length, 36 in.; dia., 5.16 in.; span, 11 in.; weight, 32.5 lbs.; light alloy and plastic airframe
GUIDANCE: Wire
PROPULSION: Solid
REMARKS: Kuwait Army and Finland have Vigilant units

VIGILANT



ISRAEL

Shavit Shtayem (Meteor II) (rocket)

TYPE: Meteorological research
STATUS: Development
PERFORMANCE: Only public flight test reached 48-mi. altitude
CONFIGURATION: Two-stage, solid propellant

ITALY

Meteo I, II and III (sounding rocket)

STATUS: Experimental tests
PRIME CONTRACTOR: Bombrini Parodi-Delfino
PERFORMANCE: Meteo I, 12-lb. payload to 43 mi. Meteo II, 25-lb. payload to 62 mi.; Meteo III, 25-lb. payload to 95 mi.; max. diameter, Mk. III, 21 in.
CONFIGURATION: Each two stage. Meteo II overall length, about 8 ft.; diameter, 3.95 and 6.3 in. Mk I, length 5.6 ft.; dia., 2.75 and 6.3 in.; all with cruciform fixed fins at base of each stage

Mosquito (missile)

TYPE: Antitank
STATUS: Operational
PRIME CONTRACTOR: Contraves Italiana
REMARKS: Joint production with Swiss Contraves (See details under Switzerland)

JAPAN

Mu Series (satellite)

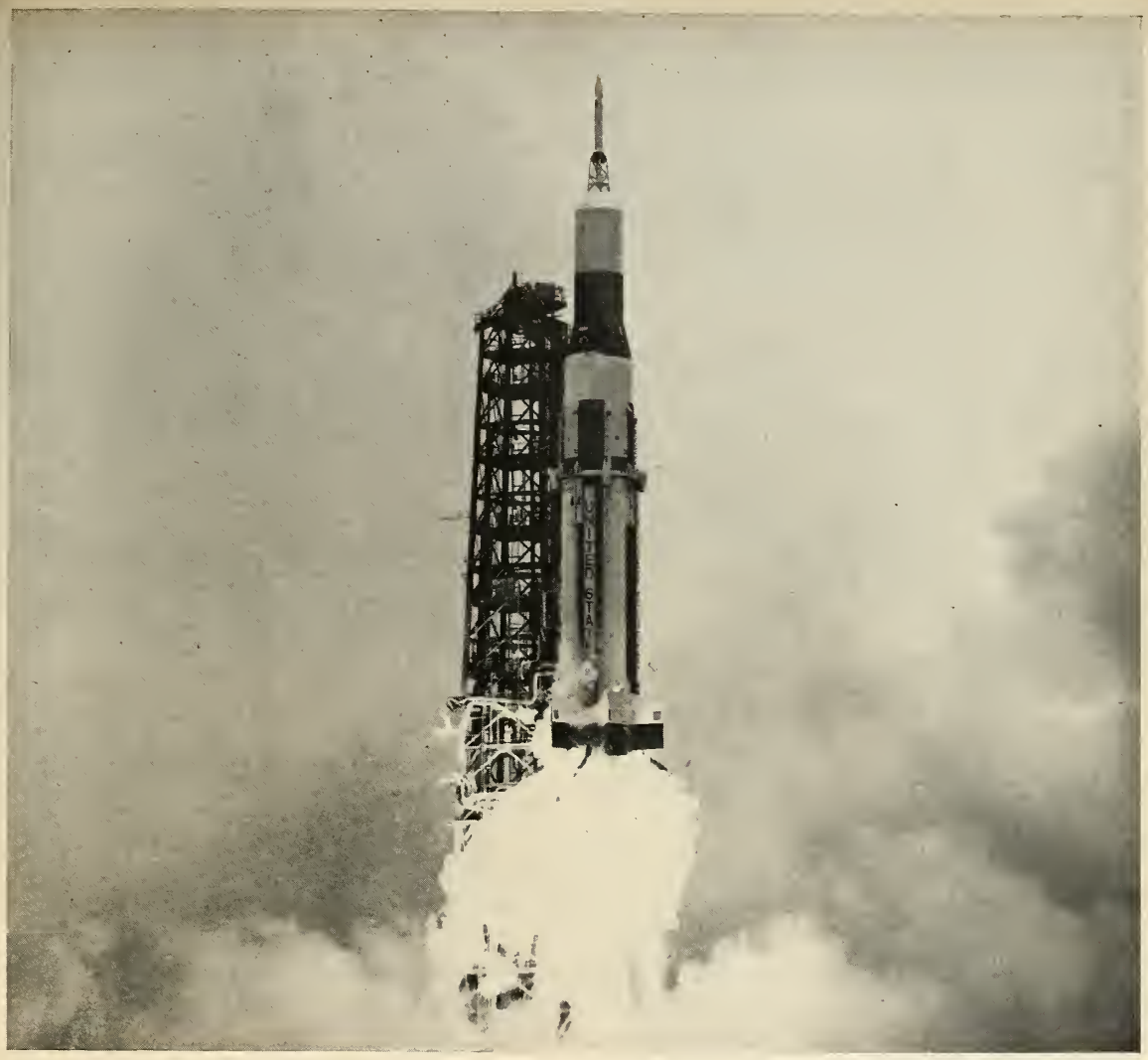
TYPE: Multi-purpose
STATUS: Early R&D
PERFORMANCE: Expected to begin with small payloads and experiments which do not duplicate other world-wide efforts
REMARKS: Five-year plan to have first Japanese satellite in orbit by 1968-69, using solid propellant booster, begun this year; space research center to be set up in Tokyo before end of year; program to cost 37 billion yen; Mu series rockets with first-stage diameter of 4.6 ft. to be used; launchings will be from Kagoshima Space Center on Kyushu

Mat I (missile)

TYPE: Antitank
STATUS: Development
PRIME CONTRACTOR: Kawasaki Aircraft Co. Ltd. (Gifu Seisakusho)
CONFIGURATION: Length, 43.5 in.; dia., 4.5 in.; span, 20.5 in.; four tail-mounted fins
Guidance: Wire

Kappa 9L (sounding rocket)

STATUS: Operational
PRIME CONTRACTOR: C. Itoh & Co., Ltd.
TEST VEHICLE PERFORMANCE: 9,020 ft./sec. at 27.3 mi.; max. acceleration 32.3 g; max. reentry deceleration —35 g.
TEST VEHICLE CONFIGURATION: Three solid stages. All-up weight: 3,446 lbs.; length, 42 ft. approx.
REMARKS: Kappa 9L developed as part of national sounding rocket program. Itoh spokesman at 1963 Paris Aerospace Show said price was $35,000 per copy; Kappa 6 rockets were fired by Yugoslavia to heights of 31 mi. during May



Raytheon high-density computer to guide Apollo

The Apollo guidance computer with its 25,000-word core rope memory and bit density of 3000 per cubic inch is the control and data processing center for the spacecraft's guidance and navigation system.

Co-developed for NASA by Raytheon's Space and Information Systems Division and MIT's Instrumentation Laboratory, the 60-pound general purpose computer uses integrated logic throughout. Its extremely small size — one cubic foot — and modular construction are based on packaged design techniques developed by Raytheon in the Polaris missile Mk-2 guidance program.

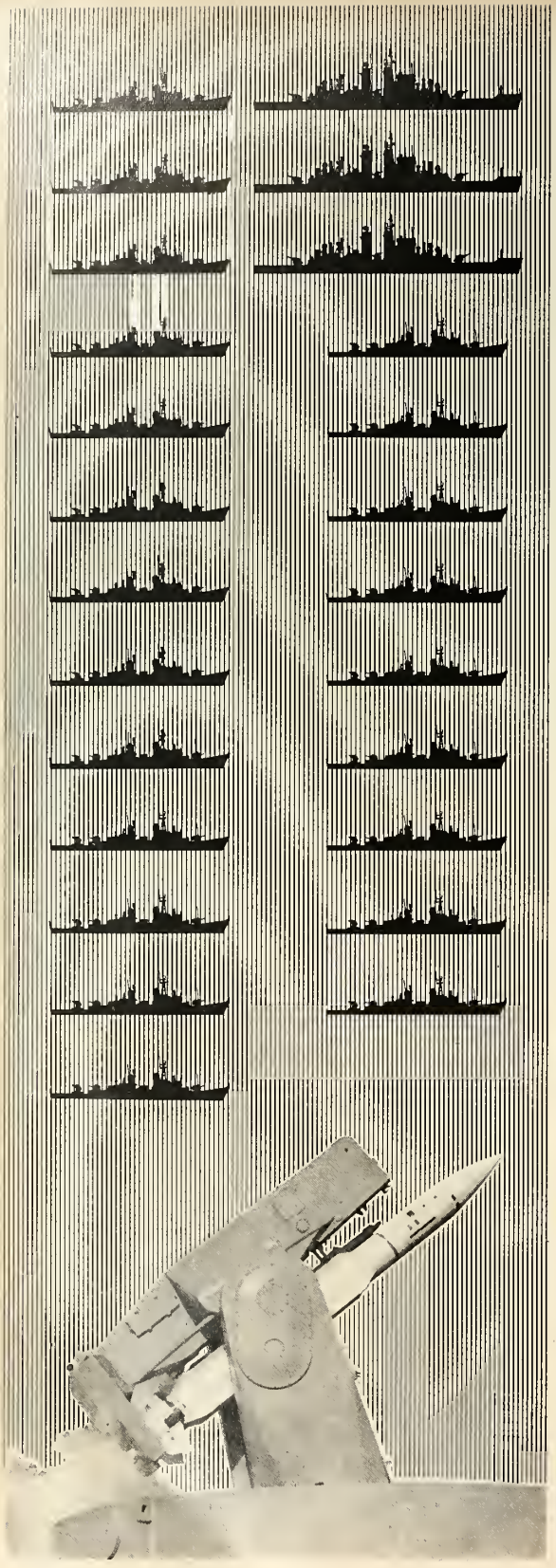
The Raytheon-produced computer controls alignment of the inertial measurement unit, positions the optical subsystem and issues commands to the vehicle. Position, velocity and trajectory data is used by the computer to solve flight and steering equations during orbital injection and mid-course guidance. Engine control signals are then issued to provide the required magnitude and direction of thrust.

Raytheon also designed and is producing the display and keyboard — the astronauts' control point for guidance and navigation. All vital maneuvering and navigation commands are processed through the display and computer and telemetered to earth for continuous monitoring.

A similar computer and display are under development by Raytheon to perform much the same function aboard the Lunar Excursion Module.

For information on Raytheon's guidance capability and detailed data on the Apollo computers, write: *M. B. Curran, Dept. 11-13A, Raytheon Company, Lexington, Mass. 02173.*

RAYTHEON



TARTAR

well tested,
well trusted

The success of Tartar's rigid test program gave ample assurance of the missile's effectiveness. With confidence, the United States Navy, since 1960 has armed 25 ships with Tartar. Tartar, designed and produced by the Pomona, California Division of General Dynamics, has also been selected for use by other navies of the Free World.

GENERAL DYNAMICS | POMONA

Lambda Series (sounding rockets)

STATUS: Flight-testing

PRIME CONTRACTOR: Notional Space Activities Council and Institute of Industriol Science, University of Tokyo

CONFIGURATION:	Lambda I	Lombda II	Lambdo III	Lambda IV
Length	32.B ft.	49.2 ft.	59.0 ft.	59.0 ft.
Weight	4.6 tons	5.7 tons	6.0 tons	6.0 tons
PERFORMANCE:				
Mox. velocity ft./sec.	6,232	B,209.B	10,824	15,744
Mox. oltitude miles (80 deg.)	49.7	211.1	310.5	931.5
Poylood (lbs.)	1,100	220	110	22

SUBCONTRACTORS: Radio Reseorch Loborotories; Yokogowa Electric Co., Ltd.; Riken Institute; Nippon-Electric Co., Ltd., Meiseri-Electric Co., Ltd.; Fuji-Precision-Machinery Co., Ltd.

REMARKS: Lambda performonce, porticulorly long horizontal range, required use of new rocket range at Kagoshima Space Center, Uchinouro

LEBANON

Cedar 4 (rocket)

TYPE: Surfoce-to-Air

STATUS: Development

CONFIGURATION: Single-stage, solid-fuel; four fins aft

REMARKS: Test launchings of vehicle and components conducted during 1964; low-quolity photo gives vehicle appearance of being two-stage sounding rocket, but coption describes it os o weopon and says it can reach altitudes of 15 mi.; whot it expects to combat at thot oltitude wos not exploined

NORWAY

Terne III (missile)

TYPE: ASW

STATUS: Operotionol on Norwegion ond U. S. ships

PRIME CONTRACTOR: Kongsberg Vapenfobrikk

PERFORMANCE: Short to medium range; firing sector 360 degrees

CONFIGURATION: Length, 6.5 ft.; diometer, 7.9 in.

GUIDANCE: None

FIRE CONTROL: Sonor, computers and remote-control louncher

PROPULSION: Solid

PAYLOAD: Terne H.E. Missile Mk 7

REMARKS: Con fire o 6-missile solvo in 5 sec. Solvo relood time is 40 sec.

SOUTH AFRICA

Surface-to-air (missile)

TYPE: Anti-oircroft

STATUS: Eorly R&D

RESPONSIBLE AGENCY: Rocket Reseorch Institute, Council for Scientific and Industriol Research, Pretoria

PRIME CONTRACTOR: Unonnounced, if ony

REMARKS: Bore onnouncement made Oct. 27, 1963, by government spokesmon who said: "The Republic has been forced by events in Africa to enter the missile field," ond odded thot o test ronge is to be set up somewhere in the republic

SWEDEN

Adam (missile)

TYPE: Air-to-surface

STATUS: Operotionol

PRIME CONTRACTOR: AB Bofors

CONFIGURATION: Length, 5.9 ft.; weight, 92.4 lbs.; HE worhead

GUIDANCE: None

Bantam (missile)

TYPE: Antitank

STATUS: Operotionol

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Range, 300 to 2,200 yds.; speed, 190 mph; chorge of 3.1 lbs. reportedly penetrotes 19 in. of armor plote

CONFIGURATION: Length, 33 in.; dio., 4.3 in.; spon, 15.8 in.; launch wt., 13.2 lbs.; glass fiber frame; weight of container and missile, 24 lbs.

PROPULSION: Solid, in two sections

GUIDANCE: Wire

REMARKS: Lightweight, weopon uses double sheoth fuze (dio. 110 mm) ensuring functioning ot impoct angle of 5° or ofter impoct against protective tank devices

Erika (missile)

TYPE: ASW, 375 mm

STATUS: Operotionol

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Ronge up to 2,000 yds. Sinking speed six fathoms per sec.

CONFIGURATION: Length with proximity fuze, 6.5 ft.; weight with fuze and hexotonal charge, 550 lbs.

REMARKS: Can use inner solid-fuel motor ond outer motor singly or together

Flora (missile)

TYPE: ASW, 375 mm

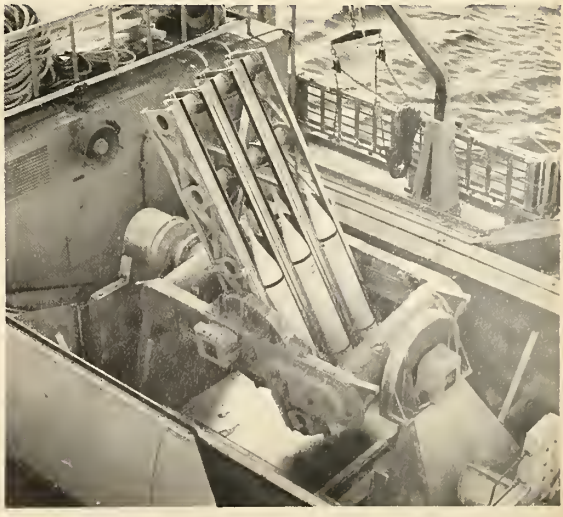
STATUS: Operotionol

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Moximum ronge, 2,600 yds.

CONFIGURATION: Length with proximity fuze, 6.5 ft.; weight with fuze and hexotonal charge, 532 lbs.

TERNE III





SAAB X

Robot 304 (missile)

TYPE: Air-to-surface
STATUS: Operotional
PRIME CONTRACTOR: Swedish Guided Missile Bureou ond Royol Swedish Armed Forces Research Establishment
PERFORMANCE: Ronge over 3 mi.
CONFIGURATION: Length, 14.8 ft.; spon, 6.8 ft.; dia., 19.4 in.; launch wt., 1,200 lbs.; four con-ard fins, small wings
GUIDANCE: Rodio commond ond autopilot
PROPULSION: Solid

Robot 315 (missile)

TYPE: Ship-to-shore
STATUS: Operotionol, phasing out
PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed forces Research Estoblishment
PERFORMANCE: Range, 10 mi.
CONFIGURATION: Length, 24 ft.; launch wt., 3,000 lbs.; four fins at midpoint, four smoll fins forword
PROPULSION: Solid booster and solid sustoiner
GUIDANCE: Rodio command
REMARKS: Being replaced by M-20

RRX-1 (rocket)

TYPE: Ramjet experimentol vehicle
STATUS: R&D
PRIME CONTRACTOR: Svensko Flygmotor Aktiebologet
PERFORMANCE: Moch 2 to 6
CONFIGURATION: Length, 6.9 ft.; diameter, 7.5 in.

Saab 'X' (missile)

TYPE: Air-to-surface
STATUS: Development
PRIME CONTRACTOR: Svenska Aeroplon Aktiebologet
CHARACTERISTICS: Supersonic, 4 highly swept fins, control surfaces in reor
REMARKS: New missile system defined by Swedish air force for concurrent development with next generation Soab 37 fighter. Few detoils released

Frida, Gerda (missiles)

TYPE: Air-to-Air
STATUS: Operotionol
PRIME CONTRACTOR: AF Bofors
GUIDANCE: None
REMARKS: Gerda is the odvonced system

M-20 (missile)

TYPE: Surface-to-surface, anti-ship
STATUS: Development
RESPONSIBLE AGENCY: Swedish Navy
CONTRACTOR: Nord-Aviation and CSF, of France, under development contract to Swedish Navy; Saab has license for Swedish monufacture
PERFORMANCE: Details scarce; however, details of the drone version CT-20 are: speed, Mach 0.85 at 33,000 ft.; endurance ot 31,000 ft., 1 hour; ceiling, 39,000 ft.
CONFIGURATION: length, 17.7 ft.; fuselage diameter, 2.17 ft.; wingspan, 11.6 ft.; wing area, 34.1 sq. ft.; launch wt., 1,480 lbs.; engine thrust, 880 lbs.; ramp-launched
GUIDANCE: Radio-command, with at least nine signal modes; target version is visualized for remote operator by luminous spot on a course plotter; this may be altered in the missile version
PROPULSION: Marbore turbojet, boosted by two jettisonable solid rockets
REMARKS: Sweden selected the French CT-20 target drone for conversion to a weapon to replace the Robot 315/316 anti-ship missile; development began in spring, 1959, with operational missile reportedly 50% heovier than target version, so performonce ond configuration details shown above will be altered to an unknown extent; final development began December, 1961, but operational date unknown; automatic handling system of Robot 315/316 adaptable to hondle M-20; budget allocation for one coastal-defense battery complete was $17 million; cost of ship installation unknown

SWITZERLAND

Mosquito (missile)

TYPE: Antitank
STATUS: Operotional
PRIME CONTRACTOR: Controves AG
PERFORMANCE: 13 g in 0.8 sec. acceleration time; velocity 300 ft./sec.; mox. range, 6,000 ft.; recoverable version hos parachute triggered by operator; reportedly penetrotes 24 in. of ormor plote with 7.3-lb. chorge
CONFIGURATION: Totol weight, 27.6 lbs.; control box, 17.6 lbs.; length, 43.7 in.; wingspan, 23.6 in.; shell diometer (w/h) 4.7 in.; armor plote penetration, over 24 in.
GUIDANCE: Wire
REMARKS: Several hundred units produced each month in joint monufocturing by Swiss Controves and Italian Contraves plonts

Sura 8-80 (missile)

TYPE: Air-to-surface
STATUS: Operational
PRIME CONTRACTOR: Hispono-Suiza (Suisse), S. A.
PERFORMANCE: Thrust, 2,640 lbs. In volley tests from aircraft at 497 mph. 50% dispersion was 10 mil-liradions

U.S.S.R.

SPACE SYSTEMS

Cosmos I-XXXV

TYPE: Space research satellites

MISSION: Check and improve "elements of space vehicle construction" and carry out research into problems posed by the space environment

STATUS: Operational, frequent launches carried out

PERFORMANCE: Orbits ronging from 107 to 900 mi. altitude; angles of inclination are 49 and 65 degrees

CONFIGURATION: Unavailable for entire series; believed to be larger than Vostok series

SPACE BOOSTER: Smaller, higher powered military rocket which was tested by firing into the Pacific Ocean during fall of 1961

PAYLOAD: Particle counters; magnetometers, micrometeorite impact sensors, and possibly comeras for surveillance

REMARKS: One of most secretive Soviet space programs; has had many launches of alleged scientific nature, but scientific results have never been releosed; Cosmos program begon in March, 1962, and has launched an average of one sotellite monthly; judging from remarks by Soviet leaders, at least some Cosmos satellites may be reconnaissonce vehicles similar to U. S. SAMOS

Elektron (satellite)

TYPE: Radiation belt research

STATUS: Multiple-launch satellites. First poir orbited Jan. 30, 1964, second pair July 11, 1964

PERFORMANCE: Reportedly excellent; Ek I orbit completely within limits of inner Van Allen belt with apogee of 3,800 mi.; Ek II intended to traverse both belts with apogee of 36,750 mi. Elektron III apogee 4,365 mi. Elektron IV, 41,076 mi.

CONFIGURATION: Ek I is approximately cylindrical, with numerous solar paddles and antennas and a hermetically sealed body; no dimensions or weights released; Ek II is apparently much larger, having fixed solar cells on its cylindrical sides, wide flared skirt and a long probe extending from its tapered nose; no dimensions or weights released; Elektron III & IV presumably same configuration

INSTRUMENTATION: Ek I: 5 scintillation, gas discharge and semiconductor radiation counters; soft corpuscular radiation detectors; beacon; piezoelectric micrometeorite detectors; mass spectrometer; solar cell samples for tests; Ek II: same radiation instrumentation as Ek I; solor cell samples; electrostatic spherical analyzer; moss spectrometer; two ferrosonde magnetometers; solar X-radiation and Cherenkov counters; scintillation counters; rodio noise detectors; charged particle trap. Instrumentation of III & IV unknown.

POWER: Level unknown, supplied by solar cells and, presumably, batteries

CONTROL: Ground command, with claim that changes in orbital parameters may be accomplished; control reliability claimed to be high

TELEMETRY: On-board storage and readout by command as well as continuous transmission

REMARKS: Soviets have released considerable detail on the equipment contained with I & II payloads, but not on equipment design nor the dimensions of the overall package. No data as yet on III & IV.

Lunik I-IV

TYPE: Space and lunor research vehicles

STATUS: Four flights—Jan. 2, Sept. 12, Oct. 4, 1959, and April 2, 1963. Lunik I—solar orbit; Lunik II—impocted Moon; Lunik III—photographed far side of Moon and presumably burned up in Eorth's atmosphere in April, 1960; Lunik IV—passed within 5,300 miles of Moon, went into deep Earth orbit and is expected to go into solar orbit. No indication of objectives or success of Lunik IV availoble

FRAME: Lunik I & II—dimensions not released; total weight, 3,245 lbs., instruments, 800 lbs. for I and 858 lbs. for II; Lunik III—cylindricol, length 87 in., diameter 47 in.; weight, 4,037 lbs. total, 959 lbs. instruments; Lunik IV—dimensions unavailble; weight, 3,135 total

INSTRUMENTATION: Internal temperature and pressure measurement instruments; devices to study gas components of interplonetary motter and corpusculor rodiation of Sun, mognetic fields of Earth ond Moon, meteoric particles and heavy nuclei in primary cosmic radiation; Lunik III also had two cameras, developing equipment, and automotic triggering devices for cameras, resulting in transmission of photos of far side of Moon

SPACE BOOSTER: Believed to be modified T-3 three-stage ICBM

REMARKS: Lunik II impacted on the Moon with instruments and a Soviet coat-of-arms; was also called Mechta (Dream). Lunik III transmitted photographs showing 70% of Moon's far side; Lunik IV took longer than usual to get to Moon, missed by 5,281 miles, and accomplished no apporent landing or photography. Tass reported, however, that it wos o success. It is believed on ottempted soft-landing by Lunik IV failed

Mars I

TYPE: Unmanned interplanetary Probe

STATUS: One flight, Nov. 1, 1962

PERFORMANCE: Speed after Earth escape, 8,793 mph. Data on Earth's radiation belts as well as space measurements ot distances up to 66 million miles from Earth were successfully transmitted

CONFIGURATION: Two hermetically sealed compartments, orbital and plonetary. Moximum length 10 ft. 10 in., 3 ft. 7 in. diometer in the orbitol compartment, maximum width 13 ft. 1½ in including solar batteries and rodiators. Weight 1,907 lbs.

INSTRUMENTATION: Photo television assembly for photographing Mortian surface. Spectro-flexometers, spectograph, mognetometers, radio telescope, sensors to measure low-energy protons and electrons

POWER: Chemical and solor batteries

REMARKS: Mars probe launched on interplanetary trajectory from Eorth orbit. Soviets predicted vehicle would come within 120,000 miles of Mars without a midcourse guidonce correction. Radio contact with spocecraft lost

Venus Probes

TYPE: Interplanetary probe launched from Eorth satellite

STATUS: At least four attempts known; no successes

PERFORMANCE: Poor; difficulty in transferring from porking orbit to interplanetary trajectory; first probe missed Venus by over 600,000 miles; remainder have been stymied while still in Earth orbit

CONFIGURATION: Probe—cylindrical payload; length, 80 in.; diameter, 41 in. without solar paddles and antennas; weight, 1,419 lbs.; configuration of Earth satellite vehicle unknown

INSTRUMENTATION: Cosmic radiation, magnetic field, micrometeorite, and other detectors; stabilizotion, temperature control, telemetry ond other control equipment

REMARKS: May 22, 1963, attempt apparently disintegrated while still in Eorth orbit, NASA lists rocket stages and 24 pieces in orbit but no transmission information; considerable difficulty experienced by USSR in transferring all interplonetary vehicles from Earth orbit. Sputnik VII, Sputnik VIII and the unnamed Moy 22 satellite ore considered abortive attempts. On April 2, 1964, USSR launched "Zond 1" with an unannounced destination, but subsequent course changes indicate it may be headed for Venus; it was scheduled to pass Venus during the latter part of July, 1964.

Vostok I-VI

TYPE: Manned spacecraft

STATUS: Single flights, Vostok I, April 12 and Vastok II, Aug. 6, 1961; twa double flights, Vostok III & IV, Aug. 11/12, 1962; and Vostok V and VI, June 14/16, 1963

PERFORMANCE: Vostok I, one orbit at 187/108 mi.; Vostok II, 17½ orbits at 115/110 mi.; Vostok III, 64 orbits at 145/112 mi.; Vostok IV, 48 orbits at 147/111 mi.; Vostok V, 82 orbits at initial 130/108 mi.; Vostok VI, 49 orbits at 133.9/109 mi.

FRAME: Overall length (est.) 35 ft.; diameter (est.) 8.8 ft.; re-entry body (est.) 17 ft.; total weight, Vostok I, 10,418 lbs.; Vostok II, 10,430 lbs.; Vostok III, "about 5 tons;" Vostok IV, same; Vostok V, same; Vostok VI, same

INSTRUMENTATION: Radio & TV equipment for biomedical monitaring, automatic life support equipment; both automatic and manual contral equipment; biomedical specimens for radiation experiments

SPACE BOOSTER: Not revealed

REMARKS: Two near-rendezvous double flights have been carried out by the USSR, and the second seemed to go awry. Vostok VI carried a woman; Vostok V appeared to be in improper orbit, which decayed rather rapidly and was considerably different from that of its running mate, preventing any possibility of rendezvaus

MISSILES

Air-to-Air (missile)

TYPE: Interceptor armament

STATUS: Unknown

PERFORMANCE: Unknown

CONFIGURATION: Length, about 9.5 ft.; body dia., about 6.5 in.; main fin span, about 39 in.; rear fin span, about 35 in.; hos one set of four sharply-swept delta fins and one set of narrow squarish cruciform fins at tail

PROPULSION: Presumably solid

GUIDANCE: Unknown

REMARKS: Armament of Soviet Fiddler interceptor

Air-to-Air (missile)

TYPE: Long-range interception

STATUS: Unknown

PERFORMANCE: Unknown

CONFIGURATION: Length, 14.2 ft.; dia., 9 in.; rear fin span, 45 in.; forward fin span, 34 in.; two sets of squarish fins, one set at tail and other about midpoint

PROPULSION: Presumably solid

GUIDANCE: Unknown

REMARKS: This weapon has been publicly shown mounted on a Soviet interceptor known to NATO as Flipper, Mig 23

Air-to-Air (missile)

TYPE: Interceptor armament

STATUS: Operational

PERFORMANCE: Unknown

CONFIGURATION: length, 9.75 ft.; body dia., about 4 in.; rear fin span, about 19 in.; forward fin span, about 10 in.; appears to be in Sidewinder class, but longer and thinner

PROPULSION: Presumably solid

GUIDANCE: Unknown, but believed IR

Air-to-Surface (missile)

TYPE: Bomber standoff weapon

STATUS: Presumably operational

PERFORMANCE: Unknown

CONFIGURATION: Length, about 19 ft. overall; height (incl. fin) about 6 ft.; body dia., about 4 ft.; wing and fin spans unknown; appears similar to Ryan Firebee; has two aerodynamic "fences" on upper surface of eoch wing

PROPULSION: Apporently turbojet

GUIDANCE: Unknown

REMARKS: Wing-mounted under Badger bombers at public displays; may not be a missile at all, but a target drone

Air-to-Surface (missile)

TYPE: Bomber standoff weapon

STATUS: Presumably operational

PERFORMANCE: Unknown

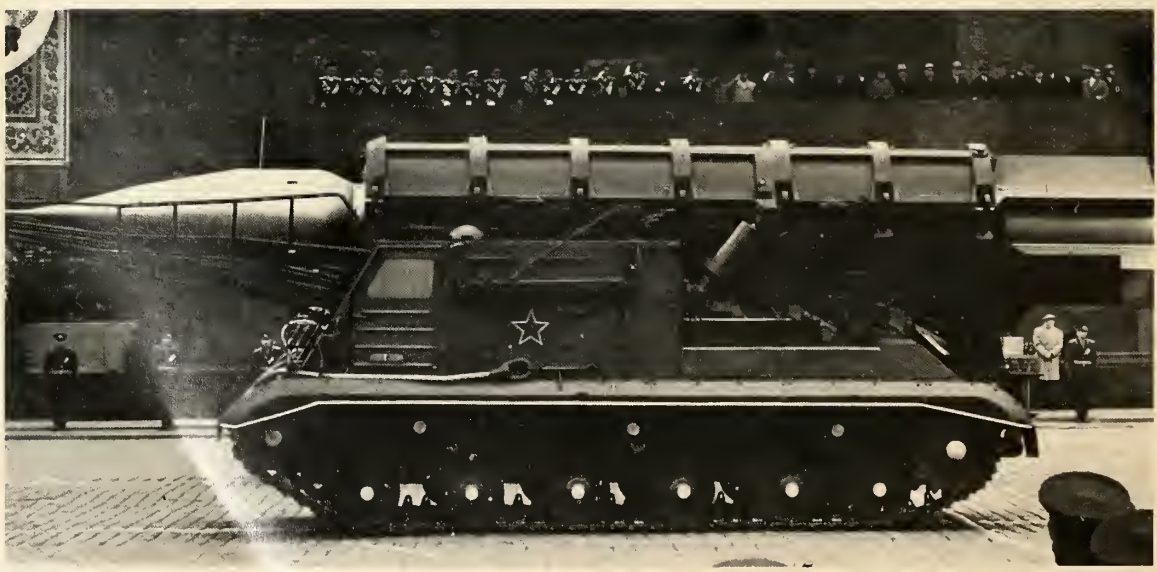
CONFIGURATION: Length, about 32 ft.; body dia., about 3.75 ft.; overall ht. (incl. vertical fin and engine nacelle) about 8.5 ft.; horizontal wing and fin spons unknown; appears to be in Hound Dog class, with shorter and fatter body, as well as rear horizontal stabilizers instead of canard arrangement

PROPULSION: Turbojet or ramjet

GUIDANCE: Unknown

REMARKS: Carried in public displays by Soviet Badger bombers under fuselage

FROG



Air-to-Surface (missile)

TYPE: Bomber standoff weapon

STATUS: Unknown, presumably operational

PERFORMANCE: Unknown

CONFIGURATION: Length, about 58 ft.; dia. about 7 ft.; wingspan, unknown; height (incl. fin), about 13 ft.; winged, pilotless-bomber type design

PROPULSION: Unknown, probably turbojet

GUIDANCE: Unknown

REMARKS: Carried in public displays by Soviet Bear bomber

Air-to-Surface (missile)

TYPE: Tactical strike

STATUS: Presumably operational

PERFORMANCE: Unknown, probably in Bullpup class

CONFIGURATION: Length, 11.5 ft.; body dia., about 1 ft.; rear fin span, 3 ft.; forward fin span, about 1.75 ft.; resembles Bullpup AGM-12, but with larger fin areas and smaller body dia.

PROPULSION: Presumably solid

GUIDANCE: Unknown

REMARKS: Carried in public displays by Soviet fighter-bombers

Air-to-Surface (missile)

TYPE: Bomber standoff weapon

STATUS: Presumably operational

PERFORMANCE: Unknown

CONFIGURATION: Length, about 30 ft.; body dia., max. 3.5 ft. at air intake duct; vertical fin span, about 7 ft.; horizontal wing and fin spans unknown; appears to be in Blue Steel class

PROPULSION: Apparently turbojet or ramjet

GUIDANCE: Unknown

REMARKS: Carried in public displays by new Blinder supersonic bomber

Air-to-Surface (missile)

TYPE: Helicopter armament

STATUS: Presumably operational

PERFORMANCE: Unknown

CONFIGURATION: Length, about 8 ft.; dia., about 1 ft.; rear fin span, about 3 ft.; forward fin span about 2 ft.; two sets of cruciform fins, with rear set apparently fixed and forward set movable

PROPULSION: Presumably solid

GUIDANCE: Unknown

REMARKS: Carried by Soviet helicopter Harp in public display

Anti-Missile-Missile

TYPE: Re-entry body interceptian

STATUS: Unknown, probably early development

PERFORMANCE: Unknawn; Soviet claim is that it can hit "a fly in outer space"

CONFIGURATION: length, about 47 ft.; dia. of booster, 34.2 in.; dia. of sustainer, 25 in. (all dimensions approximate); three sets af fins, ane cruciform set fixed at base of booster, one small all-moving set at base of sustainer, and one large cruciform set at three-quarter point on sustainer including ailerons and stub antennas for guidance commands

PROPULSION: Probably solid

GUIDANCE: Probably radar command

REMARKS: Shown to public in Red Square on Nov. 7, 1963; some resemblance has been noted between portions af this weapon and the earlier surface-to-air weapons called SA-2 and SA-3

Frog* (missile)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 15-25 mi. estimated

FRAME: Length, 31 ft.; diameter, 3 ft.

PROPULSION: Solid

REMARKS: Similar to U.S. Honest John. Launched from tracked vehicle. Unguided. Carries HE and possibly nuclear warhead; performance details speculative

** NATO code name*

Ramjet Missile

TYPE: Battlefield support

STATUS: Apparently operational

PERFORMANCE: Uncertain, but appears capable of Mach 2.5 operation at medium altitudes and range of about 100 mi. or less

CONFIGURATION: Length, about 30 ft.; afterbody dia., about 3 ft.; diffuser dia., about 15-18 in.; twa large sets of cruciform fins, forward set all-moving, after set fixed; four solid rocket strap-on motors to accelerate vehicle to ramjet ignition velocity; ramjet body apparently integral with overall structure and no warhead separation occurs; center diffuser body projects about 8 ft. forward of ramjet intake lips and tapers to long point

PROPULSION: Four strap-on jettisonable solid rockets, then ramjet

GUIDANCE: Unknown

REMARKS: Actual mission of missile appears in doubt, since it could conceivably be either anti-aircraft or for close support of troops, although it is large enough ta be an antiaircraft weapon; is launched from a tracked vehicle equipped with an elevation beam; each vehicle carries two missiles

SA-2



SA-2 Guideline* (missile)

TYPE: Surface-to-Air

STATUS: Operational

PERFORMANCE: Unknown (see remarks below)

CONFIGURATION: Length, about 32 ft. overall; booster motor dia., about 20 in.; sustainer motor dia., about 16 in.; two sets of four fins, and two sets of small protrusions which may be command guidance antennas

PROPULSION: Presumably solid

GUIDANCE: Unknown, presumably cammand guidance via radar similar to Nike series

REMARKS: Deployed by USSR in Cuba, United Arab Republic and other countries; performance unknown, but this is presumably the weapon used by Cuba (and perhaps Red China) to down several U-2 aircraft

* NATO code name

SA-3 (missile)

TYPE: Surface-to-air

STATUS: Unknown

PERFORMANCE: Unknown, but obviously improved over SA-2, which is believed to have hit several U-2 aircraft

CONFIGURATION: Length, about 37.5 ft. overall; body dia., about 20 in.; four large fins abaut three-quarters of the length back have movable tabs, and four smaller fins near nose appear movable; staging point is not as obvious as in SA-2, and version seen may have been without boost motor

PROPULSION: Presumably solid

GUIDANCE: Presumably radar-command

REMARKS: Details speculative

Sandal* (missile)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range believed to be on order of 500 mi.

CONFIGURATION: Length, about 70 ft.; dia., about 5.6 ft.; four very small fins at tail; constont diameter throughout length of frame

PROPULSION: Liquid rocket, believed using LOX/RP1; thrust unknown but probably in 100,000 lb. class

GUIDANCE: Unknown

REMARKS: Updoted version of Shyster; is relatively mobile and approximate counterpart of Redstone with improved performance

*NATO code name

Surface-to-Surface (missile)

TYPE: Antitank

STATUS: Presumbaly operational

PERFORMANCE: Unknown

CONFIGURATION: Length, 34.5 in.; dia., 3.5 in., with slightly larger-diameter warhead; fin span, 28 in.; has oversize fins at tail

PROPULSION: Presumobly solid

GUIDANCE: Unknown

REMARKS: Armament for small vehicles

Surface-to-Surface (missile)

TYPE: Antitank

STATUS: Presumably operational

PERFORMANCE: Unknown

CONFIGURATION: Length, 41.2 in.; dia., 4.1 in.; fin span, 22.2 in.; has four fins aft and rounded nose

PROPULSION: Presumably solid

GUIDANCE: Unknown

REMARKS: Armament for small vehicles

Shyster* (missile)

TYPE: Surface-to-surface MMRBM

STATUS: Obsolescent

PERFORMANCE: Range believed ta be an order of 350-400 mi.

CONFIGURATION: Length, 66.5 ft.; dia., 5.6 ft.; four small fins at tail similar to fins first seen an Thor IRBM and later removed; constant diameter throughout length of frame

PROPULSION: Liquid rocket, believed using LOX/RP-1; thrust unknown, but probably in 70-80,000 lb. class

GUIDANCE: Unknown

REMARKS: One of earliest shown Soviet long-range missiles; believed to be the aging offspring of the V-2 continuatian carried out in the USSR by German workers after the war; now replaced by Sandal

*NATO code name

Snark* (missile)

TYPE: Submarine-launched, ballistic

STATUS: Unknown, but believed to be deployed in limited quantities

PERFORMANCE: Unknown; open to speculation as to whether underwater launch is possible

CONFIGURATION: Length, about 47.5 ft.; dia., 5.9 ft. max., 4.1 ft. at smallest cylindrical section; no fins or other major protrusions, but cluster of what are apparently seven rocket nozzles at base; may have as many as three stages

PROPULSION: Very likely solid propellants

GUIDANCE: Unknown, probably all-inertial

REMARKS: Shown in Red Square on May Day, and described as both a shipboard and field weapon

*NATO code nome

SNARK



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Status of FY 1965 Budget Requests

Department of Defense Appropriations (H.R. 10939)

Figures in parentheses show amount cut by House from DOD request.

MILITARY PERSONNEL

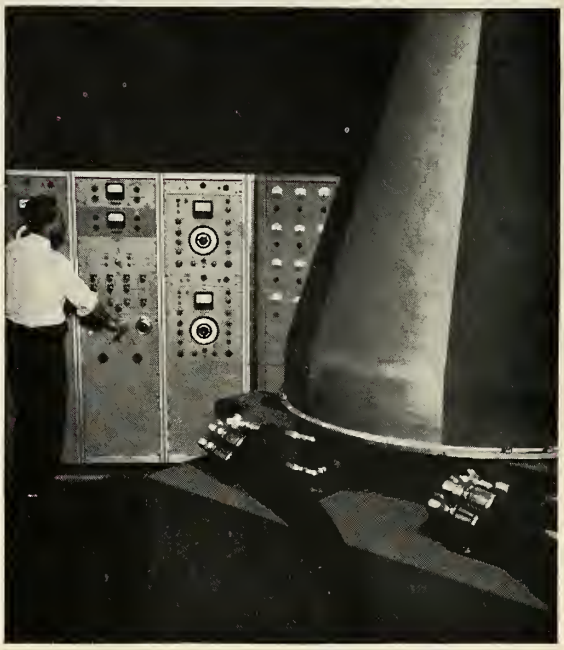
TOTAL—MILITARY PERSONNEL	$14,565,000,000

OPERATIONS AND MAINTENANCE

Operations and Maintenance, Army	**3,429,000,000**
Reductions were made in the following specific categories:	
Real estate management (1,000,000)	
Recruiting and other personnel support (2,000,000)	
Nonreimbursable support to other agencies (2,000,000)	
Unspecified reductions (29,000,000)	
Operations and Maintenance, Navy	**3,128,000,000**
Reductions were made in the following categories:	
Installation of a management information system (2,208,457)	
Civilian personnel (2,000,000)	
Defense weapons system management school (800,000)	
Unspecified cuts (25,991,543)	
Operations and Maintenance, Marine Corps	**188,000,000**
Operations and Maintenance, Air Force	**4,560,000,000**
Only specific cut was in office equipment (1,000,000)	
Unspecified cuts (45,000,000)	
Operations and Maintenance, Defense Agencies	**511,986,000**
Unspecified cuts (5,000,000)	
Operation and Maintenance, Army National Guard	**188,000,000**
Operation and Maintenance, Air National Guard	**236,000,000**
National Board for the Promotion of Rifle Practice, Army	**484,000**
Claims, Defense	**23,000,000**
Contingencies, Defense	**15,000,000**
Court of Military Appeals, Defense	**530,000**
TOTAL—OPERATION AND MAINTENANCE	12,280,000,000

(continued on p. 144)

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PROCUREMENT

Procurement of Equipment and Missiles, Army . . **1,650,196,000**

Reductians were made in the fallowing categaries:
Cammunications and Electranics (12,504,000)
Redeye (19,000,000)
Multi-system test equipment (29,700,000)
Mobile air defense program (15,000,000)
Reduced Army requirements (52,600,000)

Procurement of Aircraft and Missiles, Navy . . **2,496,358,000**

Reductians were made in:
F-4 aircraft pracurement pragram (12,422,000)
Electronics equipment (6,220,000)

Shipbuilding and Conversion, Navy . . . **1,961,176,000**

Reduction was made in the funds far electranics equipment (4,824,000)

Other Procurement, Navy **1,041,440,000**

Reduction was made in the funds far communicatians and electranic equipment (16,560,000)

Procurement, Marine Corps . . **162,944,000**

Reductians were made in:
Cammunicatians and electranics equipment (3,856,000)
Redeye (10,500,000)
Decreased Marine requirements (3,700,000)

Aircraft Procurement, Air Force **3,554,737,000**

Reductians were made in:
Electranic equipment (13,976,000)
F-4 aircraft procurement pragram (26,087,000)
Aircraft replenishment spares and spare parts (68,200,000)

Missile Procurement, Air Force **1,730,000,000**

No reductian

Other procurement, Air Force **779,096,000**

Reductian in electranics and cammunicatians equipment (22,904,000)

Procurement, Defense Agencies **62,000,000**

Na reductian

TOTAL—PROCUREMENT
13,437,947,000

RESEARCH, DEVELOPMENT, TEST AND EVALUATION

Research, Development, Test and Evaluation, Army **1,340,045,000**

In additian ta cuts made by the authorizatian bill (P.L. 88-288), deletian af equipment far a classified facility was made (5,000,000)

Research, Development, Test and Evaluation, Navy **1,369,560,000**

In additian ta cuts made by the autharizatian bill (P.L. 88-288), the fallawing reductions were made:
Research (5,000,000)
Center far naval analyses (2,000,000)
SAM missile develapment (1,000,000)
X-22 VTOL (500,000)

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Research, Development, Test and Evaluation, Air Force	**3,118,000,000**
Amount recommended is the net ofter deletions in the authorization bill (P.L. 88-288) and the odd-on for the follow-on strotegic bomber ore token into occount. Reduction wos mode for:	
Communications sotellite development (22,000,000)	
Research, Development, Test and Evaluation, Defense Agencies	**498,715,000**
Reduction wos made for development of o communications sotellite (1,500,-000) in oddition to cuts mode by the outhorizotion bill (P.L. 88-288)	
TOTAL—RESEARCH, DEVELOPMENT, TEST AND EVALUATION	6,476,320,000
Emergency Fund, Defense*	**150,000,000**
* Provision is mode for 150,000,000 odditionol to be derived by tronsfer from other DOD oppropriotions ond 200,000,-000 to be ovoiloble by tronsfer under provisions of the oppropriotions oct.	
TOTAL—ALL AGENCIES	46,759,267,000

RECAPITULATION

Department of the Army	**11,346,125,000**
Department of the Navy	**14,263,578,000**
Department of the Air Force	**18,489,333,000**
Defense Agencies	**2,660,231,000**
TOTAL—DEPARTMENT OF DEFENSE	46,759,267,000

NASA FY '65 Authorization

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RL-10 engine	17.9
F-1 engine	64.1
J-2 engine	61.6
Saturn I	120.6
Saturn IB	260.1

(continued on p. 146)

REFRACTORY METALS APPLICATION NOTES

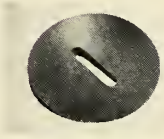
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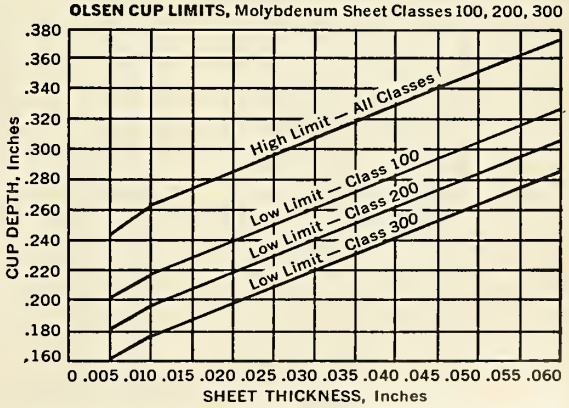


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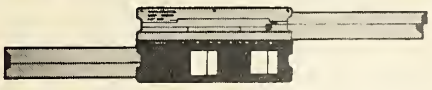


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Saturn V	988.4
Apollo support	209.2
Advanced Missions	26.0
Studies	26.0
Completed Missions (Mercury)	

OFFICE OF SPACE SCIENCE & APPLICATIONS

Geophysics and Astronomy	177.5
Supporting research and technology	14.8
Orbiting solar observatories	19.6
Orbiting astronomical observatories	44.0
Orbiting geophysical observatories	52.2
Explorers	31.9
Sounding rockets	15.0
Lunar and Planetary Exploration	283.1
Supporting research and technology	18.1
Ranger	10.8
Surveyor	123.7
Lunar orbiter	44.3
Mariner	54.1
Pioneer	21.1
Manned space science	11.0
Sustaining University Program	46.0
Training grants	25.0
Facility grants	10.0
Area research	11.0
Launch Vehicle Development	128.2
Supporting research and technology	4.5
Centaur	92.0
Operational support	14.2
FLOX	17.5
Scout	—
Delta	—
Bioscience	31.0
Supporting research and technology	11.8
Biosatellites	19.2
Meteorological Satellites	37.5
Supporting research and technology	6.6
Tiros	5.8
Nimbus	18.9
Meteorological sounding rockets	3.0
Synchronous meteorological satellites experiments	3.2
Communications Satellites	11.4
Supporting research ond technology	2.3
Echo	0.3
Reloy	1.8
Syncom	2.0
Early gravity gradient experiment	5.0
Advanced Technological Satellites	31.0
Supporting reseorch and technology	1.1
Advanced technological sotellites	29.9

OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY

Basic research	21.0
Space vehicle systems	37.0†
Supporting research and technology	25.3
Small flight projects	3.0
Scout re-entry	2.0
Saturn micrometeoroid	2.6
Project FIRE	3.0
Space vehicle recovery	1.1
Scout micrometeoroid	—
Electronic systems	27.0
Supporting reseorch and technology	24.0
Small flight projects	3.0
Human factor systems	15.5
Supporting research and technology	12.5
Small flight projects	3.0
Nuclear-electric systems	47.1
Supporting reseorch and technology	24.0
SNAP-8 development	18.0
SERT	5.1
Small flight projects	—
Nuclear rockets	58.0
Supporting research and technology	23.0
Nuclear rocket development station operotions	0.5
RIFT	0.0

(continued on p. 147)

Kiwi	0.0
Nerva	34.5
Chemical propulsion	62.8
Supporting research and technology	25.8
Small flight projects	—
Experimental engines	38.0
M-1 engine	(24.0)
Large solid mator demonstration	(15.0)
Space power	12.5
Aeronautics	37.0
Supparting research and technalogy	9.4
X-15	0.9
Supersonic transpart	24.7
V/STOL	2.0

† Small Congressianal reductian in total. NASA ta decide which program areas shauld be reduced.

OFFICE OF TRACKING AND DATA ACQUISITION

Tracking and data acquisition	267.9
Supporting research and technolagy	15.5
Netwark aperatians	99.8
Equipment and campanents	152.6

TECHNOLOGY UTILIZATION AND POLICY PLANNING

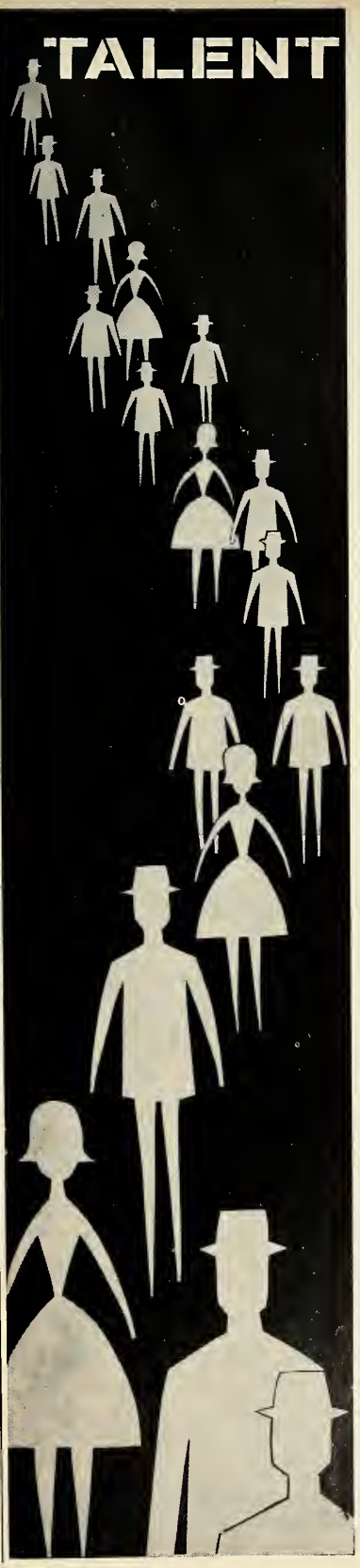
Technology utilization	5.0

FY '65 MAJOR NASA CONSTRUCTION

(in thausands af dallars)

Ames Research Center	5,668
Administrative management building	1,218
Flight simulatar for advanced aircraft	2,630
Instrument building extension	1,820
Electronics Research Center	10,000
Center support facilities	1,950
Electronic components labaratory	3,200
Engineering and administrative building	1,850

(continued on p. 148)



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A career in science or engineering has realistic demands . . . it has no place for false values at either the mechanistic or human level. Here at the Naval Laboratories in California, talent, skill, experience, intelligence, education and the ability to work well with associates are the only acceptable criteria for employment in any of the scientific disciplines . . . no others are considered.

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U.S. NAVY ELECTRONICS LABORATORY (NEL), SAN OIEGO

U.S. NAVAL CIVIL ENGINEERING LABORATORY (NCEL), PORT HUENEME

U.S. NAVAL ORONANCE LABORATORY (NOLC), CORONA

U.S. NAVAL RAOIOLOGICAL OEFENSE LABORATORY (NROL), SAN FRANCISCO

U.S. NAVAL PERSONNEL RESEARCH ACTIVITY (NPRA), SAN OIEGO

U.S. NAVAL WEAPONS STATIONS, QUALITY EVALUATION LABORATORY (QEL), CONCORO

U.S. NAVAL WEAPONS STATION, QUALITY EVALUATION LABORATORY (QEL), SEAL BEACH

U.S. NAVAL SHIP MISSILE SYSTEMS ENGINEERING STATION (NSMSES), PORT HUENEME

U.S. NAVAL FLEET MISSILE SYSTEMS ANALYSIS ANO EVALUATION GROUP (NFMSAEG), Corona

U.S. NAVAL LABORATORIES IN CALIFORNIA

Qualification and standards laboratory	3,000
Goddard Space Flight Center	1,221
Earth albedo and infrared simulation system for the space environment simulator	500
STADAN engineering and real time station	365
Relocation of Wallops Island training facility	356
Jet Propulsion Laboratory	3,582
Addition to spacecraft development engineering building No. 233	545
25-ft. simulator modification	2,312
Supporting services building—(Edwards Test Station)	360
John F. Kennedy Space Center	87,070*
Addition, manned spacecraft checkout building	16,316
Advanced Saturn launch complex No. 39	63,284
Extension to control supply complex	952
Manned spacecraft static test facility	2,780
Propellant systems components laboratory	588
Utility installations—new area	5,600
Modifications to Centaur launch complex No. 36	451
Modifications to launch complex No. 17	465
Langley Research Center	3,938
Thermal control housing and building addition for dynamics research laboratory	761
Fatigue research laboratory	1,099
Control high-pressure air supply	1,740
Lewis Research Laboratory	770
34.5-138 KV electrical power substation	770
Manned Spacecraft Center	23,907*
Modification to environmental testing laboratory	9,416
Electronic systems compatibility facility	4,110
Lunar mission and space exploration facility	2,647
Control data facility extension	2,658
Technical services facility	2,240
Flight crew operations facility	1,764
Marshall Space Flight Center	14,523*
Extensions to Saturn V ground support equipment test facility	2,495
Cold flow test facility	2,368
Extension of components test facility instrumentation	1,814
Extension to the propulsion and vehicle engineering laboratory	2,230
Saturn support test area	3,206
Michoud Plant	6,207*
Facility additions to support Saturn S-1B and S-1C production	2,735
Alterations to Saturn first stage production facilities	628
Central computer facility extension and alterations	1,160
Mississippi Test Facility	58,891*
Additional utility installations and support facility	9,533
Components service facility	5,499
Saturn V first stage (S-1C) static test facility	26,384
Saturn V second stage (S-11) static test facilities	20,575
Various locations	35,362*
Facilities for F-1 engine program	2,707
Facilities for J-2 engine program	10,971
Facilities for S-11 stage program	2,024
Facilities for S-IVB stage program	10,709
Facilities for M-1 engine program	3,970
Addition to space radiation effects laboratory for added capabilities	1,876
Apollo network ground stations—new stations	4,010
Apollo network ground stations—additions	1,330
Wallops Station	1,749
Launch area modification	629
Support facilities	1,120

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Total	$262,878
TOTAL FY '65 NASA BUDGET	$5.227

* Manned Space Flight Construction Projects reduced by Congress by an overall 5%. NASA will decide what specific project funding levels will be reduced.

Directory of Major Procurement Contacts

ARMY

ARMY MATERIEL COMMAND

Missile Command
Huntsville, Ala.

Tel.: 431-1440, 876-2101

Director: *Maj. Gen. John G. Zierdt*

Interests are: *Free rockets, guided missiles and associated equipment.*

Director of R&D
Bldg. T-7, Gravelly Point
Washington 25, D.C.

Tel.: OX 7-4248

Director: *Brig. Gen. W. G. Merriam*

Director of Procurement and Production
Bldg. T-7, Gravelly Point
Washington 25, D.C.

Tel.: OX 5-4471

Director: *Brig. Gen. E. J. Gibson*

Small Business and Labor Surplus Officer: *H. M. Evans, Tel. OX 7-6978*

Weapons Command
Rock Island, Ill.

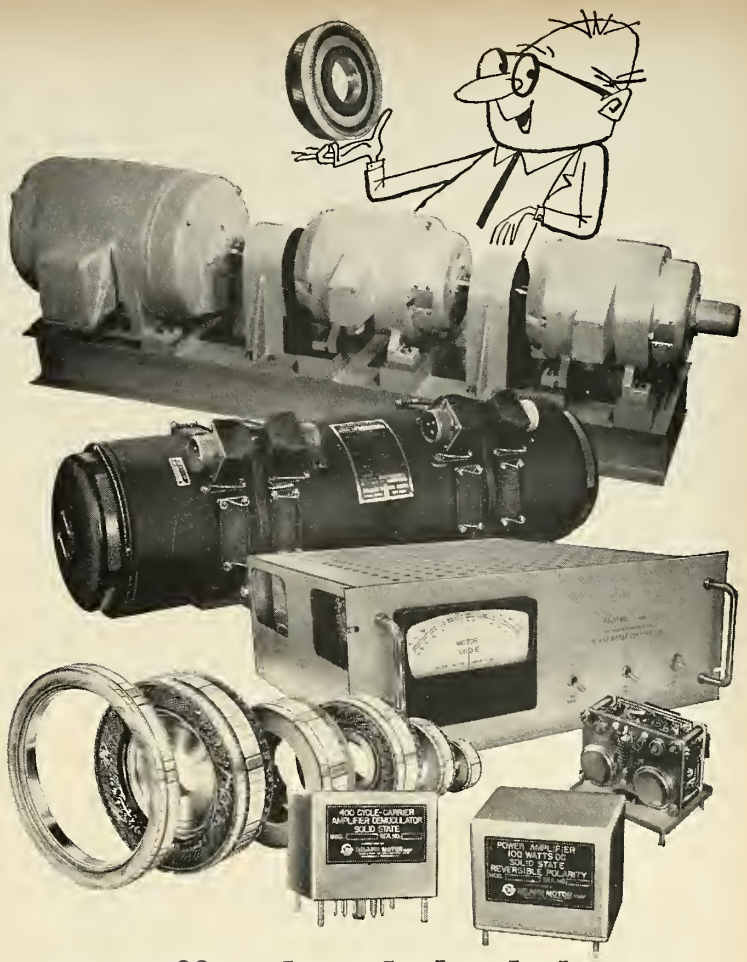
Tel.: 788-8411

Mail Symbol: *AMSWE*
Director: *Brig. Gen. Roland B. Anderson*

Interests are: *Weapons and combat vehicles.*

Munitions Command, Picatinny Arsenal, Dover, N.J.

Tel.: FO 1-2100



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Mail Symbol: *SMUPA*
Director: *Maj. Gen. F. A. Hansen*

Interests are: *Nuclear and non-nuclear ammunition rocket and missile warhead sections; propellants; explosives and pyrotechnics; meteorological and propellant-actuated devices; CBR materiel.*

Electronics Command
Fort Monmouth, N.J.

Tel.: 53-2110

Director: *Maj. Gen. F. W. Moorman*

Interests are: *Communications; electronic warfare; combat surveillance; automatic data processing; radar; and meteorological materiel.*

Mobility Command
Centerline, Mich.

Tel.: 536-1380

Director: *Maj. Gen. Alden K. Sibley*

Interests are: *Aeronautical; aerial delivery; surface transportation; power generation construction, surface, barrier and bridging equipment; general purpose vehicles; general support equipment and supplies.*

Supply and Maintenance Command
Washington, D.C.

Tel.: OX 6-8163

Director: *Lt. Gen. Jean E. Engler*

Interests are: *Repair parts, spares and logistic support of army equipment.*

Test and Evaluation Command
Aberdeen Proving Ground, Md.

Tel.: 272-4000

Director: *Maj. Gen. James W. Sutherland, Jr.*

Interests are: *Test equipment and instrumentation.*

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Rm. 0349, 18th and Constitution Ave.
Washington 25, D.C.

Tel.: Ox 6-2905

Director: *Capt. R. A. Helsel*
Code: *NP*
Small Business Officer: *J. F. Lenahan, OX 6-4972*
Rm. 0308, code: NSB

Air Frames Div.
Rm. 0347-A
18th and Constitution Ave.
Washington 25, D.C.

Tel.: OX 6-3568

Director: *R. S. Young*
Code: *NPAF*

Components and Underwater Systems Div.
Rm. 0348
18th and Constitution Ave.
Washington 25, D.C.

Tel.: OX 6-4510

Director: *J. A. Ross*
Code: *NPCU*

Missiles Systems Div.
Rm. 0348
18th and Constitution Ave.
Washington 25, D.C.

Tel.: OX 6-2718

Director: *J. W. Frankel*
Code: *WPMS*

Special Projects Div.
Rm. 3130, Munitions Bldg.
19th and Constitution Ave.
Washington 25, D.C.

Tel.: OX 6-5900

Director: *Cmdr. W. F. Hawley*
Code: *NPSP*

AIR FORCE

SYSTEMS COMMAND

Headquarters AFSC
Andrews AFB, Md.

Tel.: 981-9111 Area Code 301
(Washington, D.C.)

Mail Office Symbol: *SCKPP*
Contractor Relations and Sources: *William S. Catts*
Contractor Relations Officer: *S. Milnovsky*
Small Business Executive: *John C. Eiden*

Electronic Systems Division
L.G. Hanscom Field, Mass.

Tel.: 274-6100 Area Code 617
(Bedford)

Mail Office Symbol. *ESKB*



Circle No. 40 on Subscriber Service Card

Contractor Relations and Sources, Small Business: *John Condon*

Interests are: *Complete acquisition program for electronic, electromagnetic information and communications systems and equipment.*

Aeronautical Systems Division
Wright-Patterson AFB, Ohio

Tel.: 253-7111 Area Code 513 (Dayton)

Mail Office Symbol: *ASKS*
Contractor Relations and Sources, Small Business: *George Rattenbury*

Interests are: *Complete development and acquisition program for aeronautical systems and their components and related Government-Furnished Aerospace Equipment (GFAE) including but not limited to aircraft engines, aircraft wheels and brakes, airborne communication systems, aircraft bombing and navigation systems, aircraft instruments; Department of Defense central procurement responsibility for ground and aerial cameras, and photographic processing equipment.*

Aerospace Medical Division
Brooks AFB, Tex.

Tel.: 532-8811 Area Code 513 (San Antonio)

Mail Office Symbol: *AMKB*
Contractor Relations and Sources, Small Business: *Mildred Gibbs*

Interests are: *Life sciences, human factors, aerospace medicine, biosciences, biomedicine, behavioral sciences, space medicine, biotechnology, human engineering, human resources, aviation medicine and space biology.*

Space Systems Division
AF Unit Post Office
Los Angeles, Calif. 90045

Tel.: 670-1444 Area Code 213

Mail Office Symbol: *SSKB*
Contractor Relations and Sources, Small Business: *Roy A. Watkins*
Procurement Sources: *Joseph Krueger*

Interests are: *Acquisition of space vehicle systems and their components.*

Ballistics Systems Division
Norton AFB, Calif.

Tel.: 889-4411 Area Code 714 (San Bernardino)

Mail Office Symbol. *BSKB*
Contractor Relations and Sources, Small Business: *L. R. McGary*

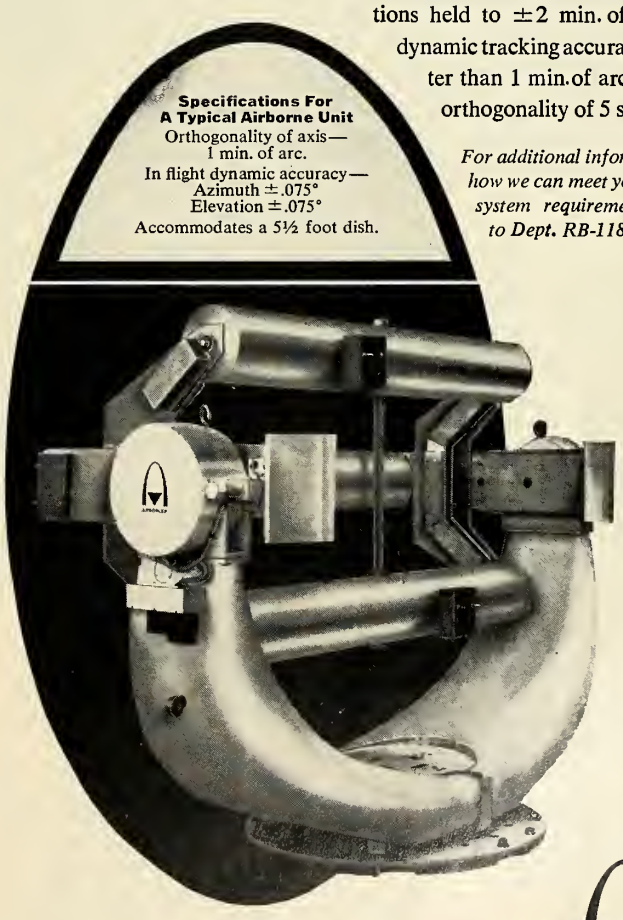
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Interests are: *Acquisition of ballistic missile systems and their components and to provide the activation of designated ballistic missile sites.*

Systems Engineering Group
Research and Technology Division
Wright-Patterson AFB, Ohio

Tel.: 253-7111 Area Code 513
(Dayton)

Mail Office Symbol: *SEKA*
Contractor Relations and Sources, Small Business: *Lawrence L. Grier*

Interests are: *Exploratory and advanced development programs in air-breathing; electric and advanced propulsion; fuels; lubricants; flight vehicle power; site support; electronic components; optronics and photo material; inertial components; vehicle electromagnetic environment; aerospace vehicle applications (reconnaissance); navigation and guidance; electronic warfare; materials sciences, metals and ceramics, nonmetallic materials; manufacturing technology and materials application; flight vehicle dynamics, performance, control, launching, alighting and structures; crew station, environmental control and escape; and aerodynamic and decelerators. Basic and applied research in bioastronautics, human engineering, training, environmental stress criteria and life support. Basic research in selected areas of physical and mathematical science.*

Air Force Flight Test Center
Edwards AFB, Calif.

Tel.: 258-2111 Area Code 805
(Edwards)

Mail Office Symbol: *FTKB*
Contractor Relations and Sources, Small Business: *J. A. Beucherie*
Contractor Relations Officer: *Ruth Davis*

Interests are: *Testing of new aircraft systems, research aircraft, aircraft components, flight test instrumentation, rocket propulsion and parachutes.*

Air Force Special Weapons Center
Kirtland AFB, N.M.

Tel.: 247-1711 Area Code 505
(Albuquerque)

Mail Office Symbol: *SWKB*
Contractor Relations and Sources, Small Business: *M. H. Nickerson*

Interests are: *Research, development test and evaluation of Air Force components of equipment related to atomic weapons.*

Air Force Missile Test Center
Patrick AFB, Fla.

Tel.: 494-7545 Area Code 305
(Cocoa Beach)

Mail Office Symbol. *MTKSA*
Contractor Relations and Sources, Small Business: *Charles C. Furtado*

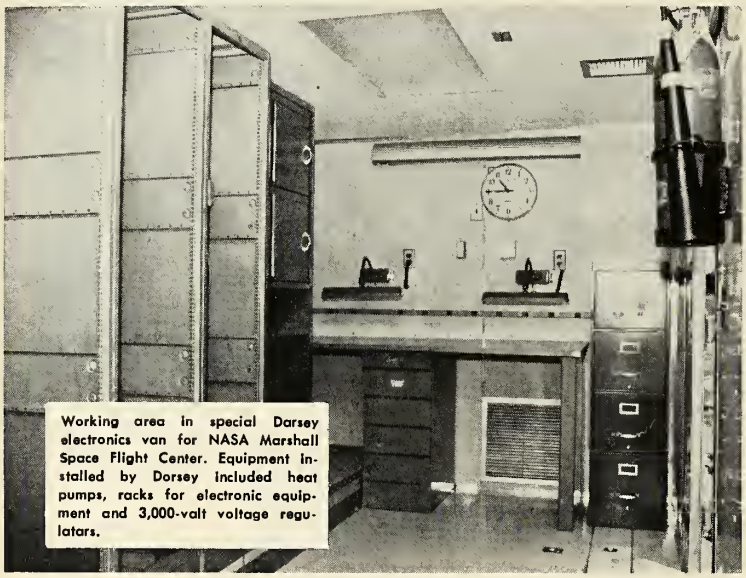
Interests are: *Test range instrumentation involving radar, trajectory computers and recorder, tracking and target analysis, wire communications, radio communications, programming timing and firing systems, telemetry receiving, data storage, data separation and presentation, optics and telemetry data reduction.*

Rome Air Development Center
Griffiss AFB, N.Y.

Tel.: 336-3200 Area Code 315
(Rome)

Mail Office Symbol: *EMKS*
Contractor Relations and Sources, Small Business: *John Vella*

Interests are: *Surveillance, electronic intelligence, communications, computer*



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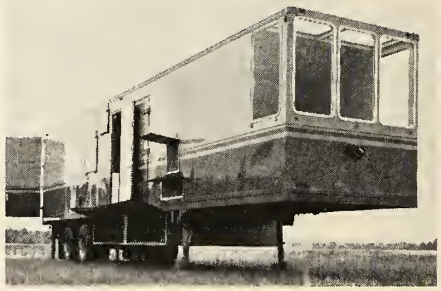
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Air Proving Ground Center
Eglin AFB, Fla.

Tel.: EG 67-2845 Area Code 305

Mail Office Symbol: *PGKS*
Contractor Relations and Sources, Small Business: *J. V. Leftwich*

Interests are: *Research, development, test and evaluation of guns and other aircraft weapons, ammunition, rockets, bombs and fire-control components and systems.*

Air Force Missile Development Center
Holloman AFB, N.M.

Tel.: 473-6511 Area Code 505 (Alamogordo)

Mail Office Symbol: *MDKB*
Contractor Relations and Sources, Small Business: *D. P. Hathcock*

Interests are: *Guided missiles, conduct of research and development of guided subsystems and components. R&D in the field of human factors including biodynamics and space biology. Execute Air Force responsibilities incident to the operation of the proving ground, including operation of special instrumentation in direct support of center mission.*

Arnold Engineering Development Center
Arnold Air Force Station, Tenn.

Tel.: 455-2611 Area Code 615 (Tullahoma)

Mail Office Symbol: *AEKB*
Contractor Relations and Sources, Small Business: *Joseph Moriarty*

Interests are: *Aerodynamics, research and development of power plants related to operation and tests of air-breathing propulsion systems, i.e., turbojet, ramjet and turboprop. Problems associated with high-temperature materials and unique mechanical, electrical and thermodynamic problems—all related to the construction of large and complex engine test facilities and wind tunnels involving heavy construction of complicated machinery and associated ducting.*

AIR FORCE LOGISTICS COMMAND

Headquarters, Air Force Logistics Command
Wright-Patterson AFB, Ohio

Area Code 513 253-7111

Director of Procurement and Production: *Maj. Gen. L. W. Fulton*

Mobile Air Materiel Area
Brookley AFB, Ala.

Area Code 205 438-6011

Director of Procurement and Production: *Col. W. H. Harrell*

Interests are: *Certain marine items, such as missile-retrieving items, and Q-2A target drone.*

Middletown Air Materiel Area
Olmsted AFB, Pa.

Area Code 717 944-5521

Director of Procurement and Production: *Col. N. J. Beaudrias*

Interests are: *Falcon, Sidewinder, Sparrow, Bullpup and Shrike; liquid propellants for missiles.*

Ogden Air Materiel Area
Hill AFB, Utah

Area Code 801 825-9711

Director of Procurement and Production: *Col. R. J. Iverson*

Interests are: *Minuteman and Bomarc missiles; F-4C and F-101, Scout launch vehicle; solid propellant boosters for Titan III; training equipment for all Air Force weapon systems.*

Oklahoma City Air Materiel Area
Tinker AFB, Okla.

Area Code 405 732-7321

Director of Procurement and Production: *Col. P. J. Kuhl*

Interests are: *B-52, KC-135, VC-137, B-47, C/KC-97, B-50; Hound Dog and Quail missiles.*

Rome Air Materiel Area
Griffiss AFB, N.Y.

Area Code 315 336-3200

Director of Procurement and Production: *Col. R. V. Kirkland*

Interests are: *Ground communications electronics systems—network of*



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Sacramento Air Materiel Area
McClelland AFB, Calif.

Area Code 916 922-1511

Director of Procurement and Production: *Col. F. E. Oliver*

Interests are: *MMRBM, all Air Force satellite systems and all satellite tracking systems.*

San Antonio Air Materiel Area
Kelly AFB, Tex.

Area Code 512 923-5411

Director of Procurement and Production: *Col. Stanley Allen*

Interests are: *Inventory management of stock items including atomic ordnance training weapons and related test and handling equipment.*

San Bernardino Air Materiel Area
Norton AFB, Calif.

Area Code 714 889-4411

Director of Procurement and Production: *Col. Abraham Driesezen*

Interests are: *All liquid fuel ICBM's —Atlas, Titan and Thor—and worldwide management of liquid rocket engines and booster systems for the three missiles; also serving as a center for missile storage, overhaul and modification.*

Warner Robins Air Materiel Area
Robins AFB, Ga.

Area Code 912 926-2208

Director of Procurement and Production: *Col. Harry Zipper*

Interests are: *Mace missile, B/RB-57 and 463L materials handling; maintenance and repair of electronics gear, such as guidance computer for Titan.*

Air Procurement Region, Europe
APO 10, New York, N.Y.

Commander APRE: *Col. Ralph A. Johnson*

Air Procurement Region, Far East
APO 323, San Francisco, Calif.

Commander APRE: *Col. Louis Garrett*

A Chronology Of Fiscal 1964

JULY, 1963

July 1 week: General Electric and Martin Co. won $123,319 NASA contracts to study application of nuclear electric power to manned orbiting space stations.

—Boeing Co. selected by NASA to carry out four-month study of lunar base concept under a $196,000 contract.

July 1: Army *Nike-Zeus* performed successfully in development tests at White Sands Missile Range, N.M.

—AF Wing II *Minuteman* fired from underground at Cape Canaveral.

July 2: Secretary of Defense Robert McNamara observed two *Polaris A-2* firings from submerged nuclear submarine Lafayette near Cape Canaveral.

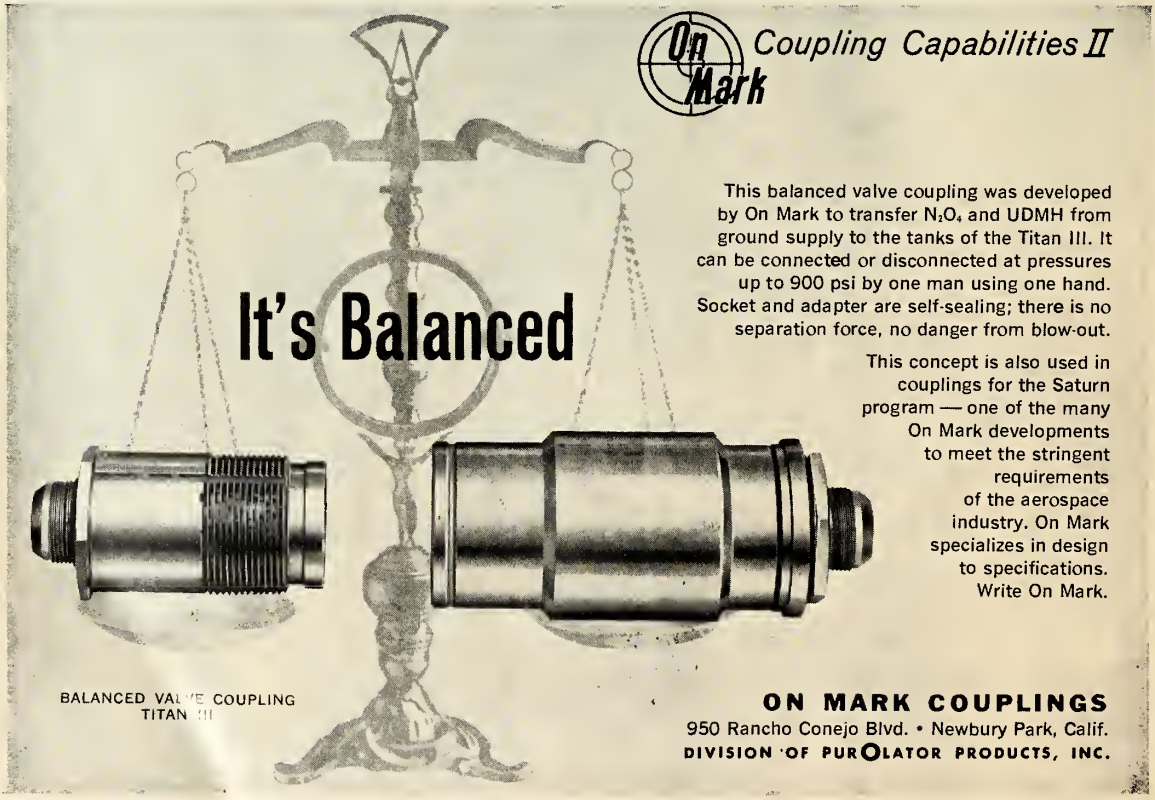
July 3: Navy fired *Polaris A-3* from land-based launch pad at Cape Canaveral.

—*Nike-Zeus* performed well in test studying precise control of the missile by ground equipment under severe conditions.

—AF *Atlas* fired from Vandenberg AFB, Calif.

July 5: AF *Minuteman* underwent its 11th launch from Vandenberg AFB, Calif., at the hands of a Strategic Air Command crew.

July 8 week: Republic Aviation Corp. selected by NASA to develop the *Ad-*



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vanced Orbiting Solar Observatory (AOSO).

—House of Representatives passed FY '64 authorization bill for NASA, with cut of $500 million from agency's request. Total bill was $5.2 billion.

July 12: AF *Minuteman* solid-fueled ICBM launched from Vandenberg AFB, Calif.

—Army *Nike-Zeus* antimissile missile, fired from Kwajalein Island, intercepted AF *Atlas* on 5,000-mi. trajectory from Vandenberg AFB, Calif. Success marked seventh intercept by *Nike-Zeus.*

—AF launched secret satellite from Point Arguello, Calif., employing *Atlas-Agena* booster.

July 15 week: Kurt R. Stehling, chief of rocket propulsion in NASA's Office of Plans and Program Evaluation, left to join Electro-Optical Systems, Inc.

—North American Aviation awarded contract for design study for converting three-man *Apollo* to small, Earth-orbiting space station in which two or three men can live for four months.

—Dr. Albert C. Hall appointed to office of Deputy Director of Defense Research and Engineering for Space Technology in DOD.

July 17: Attempts to coax *Telstar II* back to life were unsuccessful after AT&T satellite quit transmitting during 451st orbit.

July 18: 44th firing of AF *Mace* tactical missile by 4505th Missile Training Wing at Orlando, Fla., termed a "complete success."

—AF dedicates second of two Advanced Range Instrumentation Ships.

—*Polaris A-3* launched from land pad at Cape, made flight down Atlantic Missile Range.

July 19: *X-15* carried Joseph Walker to new world aircraft altitude record of 350,000 ft., bettering old record by more than 35,000 ft., from Vandenberg AFB.

—AF launches two secret satellites from Pt. Arguello. One employed a *Thor-Agena,* the second an *Atlas-Agena.*

July 20—United Technology Corp. test-fired first five-segment, 120-in. prototype solid booster for the AF *Titan III-C* vehicle, slightly ahead of schedule.

—Solar eclipse studied in most complex rocket-launching sequence yet attempted at Ft. Churchill, Canada. Launches included six *Nike-Apaches,* one *Black Brant* and one *Aerobee 150* by Air Force and NASA in Operation Probe High. Scientific experiments were 70% successful.

—NASA destroyed *Scout* shortly after liftoff. Shot would have tested re-entry materials, at Wallops Island.

July 22 week: United Arab Republic showed new missiles in Cairo during parade, including a new two-stage *"Vanguard"* rocket and a new long-range anti-aircraft rocket.

—NASA announced first six months FY 1963 procurement up 10.8%, to $1.8 billion.

July 23: Indonesian Navy disclosed launch of anti-destroyer type guided missile, which struck target 15 miles from launch site.

July 24: AF fired Wing II *Minuteman* about 2,000 mi. from Cape, in short-range test.

July 26: *Syncom II* carried into synchronous orbit by *Delta* rocket.

—*Atlas D* launched by AF from Vandenberg AFB.

—Navy launched *Polaris A-3* to test basic design and performance, from Cape Canaveral.

July 27: *Minuteman* solid-fueled ICBM fired from Vandenberg AFB.

July 29: M/R's seventh annual missile/space encyclopedia.

July 29 week: Paul Haney named public affairs chief at Manned Spacecraft Center, replacing Lt. Col. John Powers.

—AF disclosed that 6593rd Test Squadron at Hickam AFB, Hawaii has 70% success average in retrieving capsules from polar-orbit satellites launched from Vandenberg, Calif.

—NASA told it must study Boston Electronics Center proposal on basis of need and location, and report to Congress before funds will be released.

July 30: AF launched *Blue Scout, Jr.,* from Cape Canaveral in 8,000-mi.-high arc to study space beyond limits of F-layer of ionosphere.

—SAC crew launched *Atlas E* more than 7,000 mi. into PMR from Vandenberg AFB.

—AF *Thor-Agena* satellite booster fired from Vandenberg AFB.

AUGUST, 1963

Aug. 1: *Mariner II* spacecraft completed first orbit of Sun.

—Sweden launched U.S. Army *Nike-Cajun* rocket from Kronogaard to explore "bright night clouds."

Aug. 5 week: AF *Minuteman* launched from Cape Canaveral fell short of target.

—Senate voted $5.5 billion NASA authorization bill.

—M/R special report on filament winding.

Aug. 6: USSR launched *Cosmos 19,* to collect data on radiation and Earth's magnetic fields for application to future manned space flight.

Aug. 7: *Saturn S-IV* stage fired in one-minute static firing at Douglas Aircraft Co.'s Sacramento, Calif., test facility. Test was cut short of 7 minutes scheduled, because of "minor" problem.

Aug. 8: Army fired *Nike-Zeus* from White Sand Missile Range.

—*Minuteman* launched by Air Force from Vandenberg AFB.

Aug. 9: *Polaris A-2* launched from Atomic submarine Alexander Hamilton off Florida Coast.

—DOD officially confirmed cancellation of *Mobile Medium Range Ballistic Missile* system, (*MMRBM*) with announcement that Stellar Inertial Guidance System (STINGS) would be continued with General Precision, Inc.

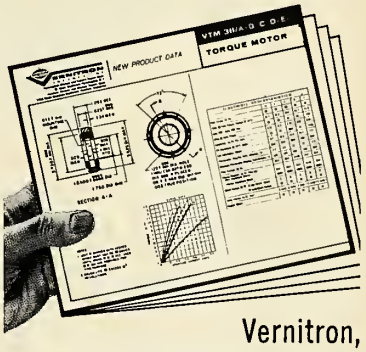
—NASA asked for bids on environmental control and life support system (ECLSS) study contract for the manned lunar base unit.

—First *Blue Streak* arrived in Australia for European Launcher Development Organization flight test, scheduled for March, 1964.

Aug. 13: *Polaris AX-3* launched from Cape Canaveral launch pad.

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Aug. 15: Air Force fired *Titan I* from Vandenberg AFB, Calif.; launch conducted by 395th strategic Missile Squadron, SAC

Aug. 17: *Centaur* vehicle stage fired for first time with both RL-10 engines equipped with flight-type propellant supply systems, including tanks, pumps and plumbing.

Aug. 19: Manned Spacecraft Center officials in sharp disagreement over effect of *Titan II* engine problems on two-man *Gemini* space program.

—North American Aviation and NASA signed space agency's largest contract, $934.4 million, for development of *Apollo* Command and Service modules.

Aug. 19: 10th anniversary of first successful *Redstone* launch celebrated by Army by firing the medium-range missile from White Sands Missile Test Range, N.M.

—Navy launched a *Polaris A-3X* from Cape land pad with special equipment to photograph exhaust flame patterns during flight.

Aug. 19 week: NASA's *Syncom II* reported on station.

—DOD announced it would not drop the 260-in. solid motor development program as previously announced.

—*MMRBM* showed some signs of life as Gen. Maxwell Taylor and other brass went to Senate Appropriations Committee to ask restoration of funds cut by House.

—Hearings began on nuclear test ban treaty, with Dr. Edward Teller protesting vigorously against it.

—GE picked to develop *Biosatellite*, involving six spacecraft.

Aug. 21: New technique for IR measurements of ballistic missile trails initiated when two IR instrument packages were injected into the exhaust of a *Titan II*.

Aug. 22: Joseph Walker set a new altitude record in NASA's *X-15*, at 66.5 mi.

Aug. 23: Two *Polaris* missiles fired from Alexander Hamilton, submerged in the Atlantic near Cape Canaveral.

Aug. 26: Wing II *Minuteman* launched from a Cape Canaveral silo dropped a dummy warhead some 4,000 mi. away in a planned mid-Atlantic target area.

—Martin Co. said operational readiness of *Titan II* would not be affected by tiny fuel leak in some second stages.

—Congress told NASA and DOD to develop by January a plan for a joint fleet of ocean tracking vessels.

—House established new R&D subcommittee of the Science and Astronautics Committee, to be headed by Rep. Emilio Q. Daddario (D-Conn.)

Aug. 28: General Dynamics/Convair *Little Joe II* rocket launched from White Sands Missile Range, in first test of the *Apollo* program.

Aug. 29: AF Strategic Air Command crew launched a *Minuteman* from Vandenberg AFB, Calif., on a 5,000-mi. trip down the Pacific Missile Range.

—AF fired a *Thor-Agena* carrying a secret satellite from Vandenberg.

Aug. 30: Navy launched a *Polaris A-3* from Cape Canaveral land pad.

—Air Force fired a *Titan I* ICBM from Vandenberg, carrying mock nuclear warhead into a target area some 5,000 mi. out in the Pacific.

—Army's *Nike-Zeus* scored third intercept of ICBM in less than a week, and its ninth hit on *AF Atlas*.

SEPTEMBER, 1963

Sept. 2 week: First public flights of NASA's M-2 lifting re-entry research glider made by Milton O. Thompson.

—AF announced it will begin work on standardized space guidance system.

—NASA asked industry to submit bids by Oct. 4 on Lunar Orbiter spacecraft, estimated to cost $75 million.

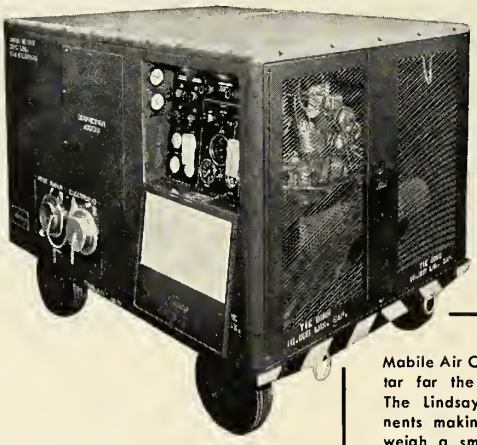
—GE official urged hardened electronic systems against damage by nuclear radiation, John R. Crittenden writes in M/R.

Sept. 6: AF launched two rockets, one an *Atlas-Agena* from Pt. Arguello, Calif., presumably into orbit. Second was *Atlas* by a Strategic Air Command crew on a training mission.

Sept. 9 week: Aerojet-General received more than $48 million to begin hardware development of the *SNAP 8* nuclear electric power unit.

—NASA announced it would drop requirement for terminal sterilization of lunar and planetary orbiter spacecraft, but continue the process for planetary landers.

—Possibility that the Soviets might have "ultimate ABM"—capable of deactivating U.S. missiles in their silos with



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electromagnetic energy from exploding high-yield bombs—revealed during nuclear test-ban treaty hearings.

—Air Force Association went on record opposing ratification of the nuclear test-ban treaty.

—Strategic Air Command crew launched an AF *Atlas* ICBM from Vandenberg AFB, Calif.

Sept. 15 week: Manned Spacecraft Center Director Robert Gilruth admitted delay in *Apollo* program past fall, 1968, lunar landing date.

—DOD gave go ahead to Air Force for requests for proposals on National Orbital Space Station, but emphasized this was no indication AF will manage eventual project.

—Soviet Union indicated official interest in joint U.S.-USSR lunar landing program, through Academician A. Blagonravov and Deputy Director of NASA Hugh Dryden.

—Weather Bureau indicated it would pull out of operational *Nimbus* meteorological satellite system, in favor of interim *Tiros* system.

—Senate Appropriations Committee voted out $47.4-billion DOD budget.

—Senate test-ban debate continued. M/R article on electromagnetic pulse effects on electronics of missile systems figured in speeches.

Sept. 18: *ASSET* shot transmitted valuable data but sank into the ocean before it could be recovered.

Sept. 23: *Titan II* ICBM launched by an Air Force crew from a silo at Vandenberg AFB in a research and development test.

—*SNAP 9A* radioisotope-fueled thermoelectric generator launched by *Thor-Able-Star* vehicle.

Sept. 23 week: Senate passed nuclear test-ban treaty, 80-19. Scientists called for release of electromagnetic pulse data.

—AF Strategic Air Command crew from Forbes AFB, Kan., fired *Atlas* from Vandenberg AFB.

Sept. 26: *Minuteman* scored its 14th West Coast firing from Vandenberg, AFB.

—Navy, using a new steam launch technique, fired a *Polaris A3* from Observation Island.

Sept. 27: AF launched a *Scout* vehicle bearing a secret payload from Vandenberg AFB.

Sept. 30: International Astronautics Federation begins fourteenth Congress in Paris.

—Army issued $213,385,000 contract to Western Electric Corp. for continued *Nike-X* development and testing, the largest single award the Army had made to date.

OCTOBER, 1963

Oct. 1: U.S.S. Andrew Jackson made its *Polaris* firing debut with launch of an *A-2* model.

Oct. 3: *Atlas F* blew up shortly after takeoff from Vandenberg AFB.

Oct. 4: Navy launched a *Polaris A-3* from the U.S.S. Observation Island, using new steam launch technique.

Oct. 7: Missiles and Rockets special report on advanced guidance and control systems.

Oct. 7 week: President Kennedy awarded Collier Trophy to seven astronauts.

—*Explorer XIV* transmitter stopped after 10 months in orbit.

—NASA wound up *Mercury* program with a report in Houston.

—NASA explained *Mercury* report to Congress, answering questions about a section criticizing industry for workmanship.

Oct. 8: *Atlas D* exploded shortly after takeoff from Vandenberg AFB.

—*Centaur* space vehicle with new RL-10 engines underwent flight-duration static test firing at General Dynamics.

—First *Gemini* spacecraft arrived at Cape for installation of instrumentation for first flight, which was to test structural integrity and flight characteristics.

—NASA reshuffled headquarters staff in a move designed to increase control over its field installations.

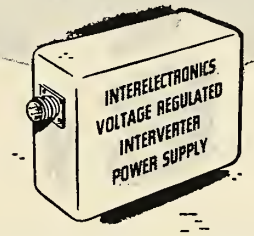
Oct. 10: President Kennedy issued new policy on patents, giving Federal government right to all inventions perfected under public-financed research.

Oct. 14 week: NASA and DOD signed agreement to insure that manned space station project is a national program.

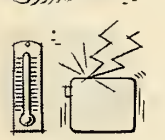
—NASA switched to *Thrust-Augmented Delta* for medium-sized scientific and applications satellites.

—Navy's *Polaris A-2* IRBM underwent firing from submarine Andrew Jackson while on a shakedown cruise off Florida.

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—After three abortive attempts to launch a pair of *Vela High-Altitude* nuclear surveillance satellites in previous week, AF finally boosted them into the sky aboard an *Atlas-Agena* vehicle.

Oct. 17: French *Véronique* rocket carried a cat into space as part of space biology research program. Animal returned to Earth by parachute.

—AF launched a *Minuteman* from Vandenberg AFB, in routine training exercise conducted by a Strategic Air Command crew.

Oct. 18: USSR launched 20th shot in the *Cosmos* series.

—Army released new details of *Lance* surface-to-surface missile system at Association of the United States Army meeting in Washington.

—Fourteen new astronauts chosen in Houston by NASA.

Oct. 25: AF launched an *Atlas-Agena* bearing an unidentified satellite from Pt. Arguello, Calif.

Oct. 28: AF *Atlas F* failed spectacularly after launch from Cape Canaveral.

—The 13-shot series of overland *Pershing* firings from Ft. Wingate, N.M., to White Sands concluded with one success and one cancellation.

—NASA decided to adopt Air Force-developed *Thrust-Augmented Thor* for use with *Agena* and *Delta* vehicles.

Oct. 29: AF launched a secret satellite aboard a *Thor-Agena* vehicle from Vandenberg AFB.

Oct. 30: France launched a two-stage *Dragon* rocket 310 mi. into space from a Sahara test site.

—AF launch crew fired a *Minuteman* from Vandenberg AFB.

NOVEMBER, 1963

Nov. 1: Soviet Union launched *Polyot-1*, an unmanned spacecraft capable of maneuvering and changing orbit in space.

Nov. 4: AF launched an *Atlas* from Vandenberg AFB, Calif., in first shot in series of re-entry tests.

Nov. 4 week: Khrushchev denied pullout from lunar landing race.

—NASA announced plans to "FLOX" the *Atlas* booster.

—Longest known experiment (30 days total) exposing humans to 100% oxygen at a simulated 27,500 ft. began at School of Aerospace Medicine, Brooks AFB.

Nov. 7: North American Aviation and NASA conducted first pad abort test flight of *Apollo* Command Module.

Nov. 7: AF *Minuteman* went out of control and exploded shortly after liftoff from a Cape Canaveral launch pad.

Nov. 9: AF used *Thor-Agena* rocket combination to launch a secret satellite from Vandenberg.

—AF conducted silo launch of a *Titan II* from Vandenberg AFB, Calif.

Nov. 11: Navy's second successful underwater firing of a *Polaris A-3* ICBM accomplished from U.S.S. Andrew Jackson, off Cape Canaveral.

Nov. 12 week: Senate Appropriations Committee voted $5.19 billion for FY '64 NASA budget.

—General Electric concluded 30-day, four-man space station simulation at Valley Forge, Pa.

Nov. 14: AF launched an *Atlas D* from Vandenberg AFB.

—SAC crew launched an AF *Titan I* from Vandenberg AFB.

Nov. 16: Navy demonstrated its *Polaris A-2* during President Kennedy's visit to Cape Canaveral.

Nov. 17 week: Senate voted to slash NASA appropriation back to House level of $5.1 billion.

—Dept. of Defense confirmed that Air Force would assume management of the Pacific Missile Range from the Navy.

Nov. 21: India fired a *Nike-Apache* rocket from that country's Thumba rocket range.

Nov. 22: President Kennedy assassinated in Dallas.

Nov. 25 week: Cape Canaveral renamed Cape Kennedy by President Johnson.

Nov. 25: Annual M/R NASA issue.

Nov. 26: *Interplanetary Monitoring Probe* launched from Cape Kennedy, boosted by NASA *Delta*.

—*Polaris A-3* missile launched at night from deck of Observation Island was destroyed by the range safety officer 52 seconds after launch when it wandered off course.

Nov. 27: AF launched *Minuteman* missile in "routine training mission" from Vandenberg AFB.

—*Atlas-Centaur 2* launch called success in spite of premature loss of telemetry.

—Volcanic eruptions spotted on Moon's surface by Lowell Observatory in England.

Nov. 29: Another "routine training mission" launch of *Minuteman*.

—Three more volcanic eruptions spotted on the Moon by Lowell Observatory astronomers.

DECEMBER, 1963

Dec. 2 week: President Johnson asked contractors to be "frugal."

Dec. 9 week: NASA and DOD signed agreement settling dispute over *Apollo* program tracking ships.

—President Johnson announced that the Department of Defense will conduct a *Manned Orbiting Laboratory (MOL)* program. *Dyna-Soar* cancelled.

—Temporary hiring ban slapped on major prime contractors in *Apollo* program by NASA.

Dec. 9: Navy fired *Polaris A-3* from Cape Kennedy land pad.

Dec. 11: *Polaris A-3* fired from USS Observation Island had to be destroyed as it wandered off course.

—Atomic Energy Commission announced that AF *Thor-Able Star* booster lifted nation's second satellite completely powered by nuclear energy into orbit from Vandenberg AFB, Calif.

Dec. 12: A Japanese-built *Lambda 2* rocket carried an instrument payload to altitude of 376 mi. from new Kagoshima Space Center.

—Army test-fired a *Nike-Zeus* from White Sands Missile Range, N.M.

—AF *Titan* launched from Cape Kennedy.

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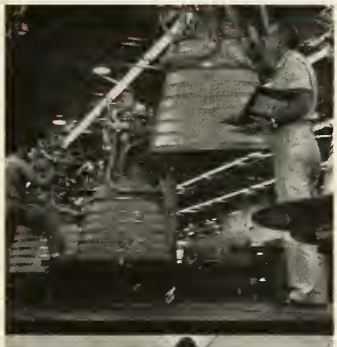
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Dec. 14: Soviet Union launched a new Earth satellite, *Cosmos 23*.

—AF fired a *Minuteman* from Vandenberg AFB.

Dec. 16: *HYDAC*, a sounding rocket built by Douglas Aircraft, launched by Navy from Pt. Arguello.

—AF *Titan II* launched from Vandenberg AFB.

Dec. 16 week: NASA acknowledged it must fight to hold 1970 lunar deadline.

Dec. 19: *Explorer 19*, launched from Pt. Arguello, Calif., quit transmitting shortly after launch.

—*Cosmos 24*, 16th satellite launched by Soviet Union in 1963, orbited.

Dec. 20: SAC crew from Malmstrom AFB, Mont., fired *Minuteman* from Vandenberg AFB in routine training flight.

Dec. 21: AF launched another secret satellite from Vandenberg with improved *Thor-Agena* booster.

—Weather Bureau's *Tiros 8* launched by NASA.

Dec. 24: Soviet-launched missile impacted in designated target area south of Hawaii and east of Johnston Island.

Dec. 29 week: Communications Satellite Corp. asked industry to submit proposals on satellite system.

—Brig. Gen. Samuel C. Phillips named deputy director of *Apollo* Program in NASA's Office of Manned Spaceflight.

—Reactor in Flight Test (RIFT) knocked out of *Rover* nuclear rocket program by NASA and AEC.

—Boeing awarded $60 million *Lunar Orbiter* contract.

JANUARY, 1964

Jan. 7: Navy launched *Polaris A-3* from Cape Kennedy land pad.

Jan. 13: Three *Polaris A-2* missiles launched in first operational tests of new steam ejection system.

Jan. 15: AF launched *Titan II* from Cape Kennedy for 5,000-mi. flight.

Jan. 16: AF scored two successes with *Minuteman*, one from Cape, one from Vandenberg AFB.

Jan. 19: AF launched *Thor-Agena* secret satellite from Vandenberg AFB.

Jan. 20: Navy launched *Polaris A-3* from surface ship off Florida coast.

Jan. 21: *Relay II*, NASA's communications satellite, sent into orbit with *Delta* rocket.

Jan. 23: AF launched *Titan II* from underground silo at Vandenberg AFB.

Jan. 24: Dr. Donald F. Hornig sworn in as Presidential advisor on Science and Technology.

Jan. 26: Atomic sub Nathan Hale launched two *Polaris A-2's* from beneath Atlantic. One was a success, the other veered off course and was destroyed.

Jan. 27 week: Presidential aeronautics and space activities report discloses that two U.S. satellites, presumably *MIDAS* follow-ons, detected launches of U.S. missiles.

Jan. 28: AF fired Wing II *Minuteman* with Wing VI second stage from Cape Kennedy.

Jan. 29: *Saturn SA-5* had resounding success, orbiting dummy payload of sand.

Jan. 30: NASA's *Ranger VI* made trip to the Moon, but TV cameras failed to function.

Jan. 31: USSR launched two *Elektron* satellites aboard a single rocket.

FEBRUARY, 1964

Feb. 3: Navy launched *Polaris A-2* ICBM from submarine James Monroe, off Florida coast.

Feb. 3 week: NASA sent justification study of proposed Boston Electronics Center to Congress.

Feb. 10 week: Air Force *Athena* test vehicle program halted as first one went off course some 50-75 mi., landing southeast of Durango, Colo.

—Dr. Eugen Saenger, one of Europe's foremost space scientists, died in West Berlin.

Feb. 11: AF launched *Minuteman* from Vandenberg AFB.

Feb. 12: AF launched *Atlas F* from Vandenberg AFB.

—AF launched *Minuteman* from Cape Kennedy in first test of penetration aids.

Feb. 15: AF launched secret satellite from Vandenberg AFB, aboard *Thor-Agena*.

Feb. 17: AF *Titan II* launched from Vandenberg AFB.

—*Polaris A-2* missile launched by submarine USS James Monroe, near Cape Kennedy.

Feb. 17 week: *Ranger VII* launch postponed as NASA began study of failure of *Ranger VI* to get lunar photographs.

—First experiments for *Biosatellite* announced by NASA.

—NASA testified that both *Apollo* and *Genini* would have water, rather than land recovery as originally planned.

Feb. 25: AF launched two *Minutemen* within 45 minutes of each other from Vandenberg AFB.

—AF also launched *Atlas-Agena* combination on an undisclosed mission from Vandenberg AFB.

—An *Atlas* and a *Minuteman* launched by the Air Force from Cape Kennedy.

Feb. 26: *Titan II* launched from Cape Kennedy by the Air Force.

Feb. 26 week: Multilateral NATO force efforts forwarded when Sec. of Defense McNamara announced that USS Biddle would act as "mixed-manning demonstration ship."

—First contracts let for standardized space guidance system, by Air Force.

Feb. 27: AF launched *Thor-Agena* from Vandenberg AFB, Calif. Payload undisclosed.

—AF *Minuteman* launched from Cape Kennedy.

Feb. 28: Army artillerymen completed series of four *Pershing* shots from Ft. Wingate, N.M., completing three out of four.

MARCH, 1964

Mar. 2 week: President Johnson disclosed existence of A-11 aircraft, and new missile.

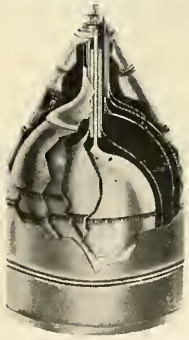
—ComSat Corp. filed plans with Federal Communications Commission to put up synchronous communications satellite system by spring, 1965.

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Mar. 9: Third *Atlas* in a year exploded in its silo, at Walker AFB, N.M.

Mar. 11: AF launched another secret satellite from Pt. Arguello aboard *Atlas-Agena* vehicle.

—Land-launched *Polaris A-2* failed to reach AMR target when second stage veered off course.

Mar. 9 week: House Space Committee cut only about $100 million from NASA budget for FY 1965.

—*Interplanetary Monitoring Probe* discovered new radiation zone, NASA announced.

Mar. 13: AF fired *Minuteman* carrying an advanced nose cone from Cape Kennedy.

—AF also fired *Blue Scout* with magnetic probe, but fourth stage failed to ignite, causing failure.

Mar. 16 week: Brig. Gen. Joseph S. Bleymaier named to post of Deputy Commander for Manned Systems of Space Systems Division of Air Force Systems Command, putting him in charge of *Manned Orbiting Laboratory* program.

—NASA requested proposals for first of about 10 studies of lunar base system. Contract called for feasibility and design study of *Apollo Logistic Support System (ALSS).*

Mar. 18: Soviet Union launched *Cosmos 26,* unmanned satellite carrying scientific instruments.

Mar. 20: *Minuteman* flew 5,000-mi. course from Cape Kennedy, 50th missile in *Minuteman* test program which began Feb. 1, 1961.

Mar. 23: AF launched *Titan* from Cape Kennedy, carrying version of malfunction detection system to be used on *Gemini.*

Mar. 23 week: Army announced it would send *Pershing* to Europe to replace *Redstone* missiles there.

Mar. 27: *Scout* used to launch Britain's *Ariel II (UK-2)* satellite from Wallops Island, Va.

—Soviet Union launched *Cosmos 27,* third in the *Cosmos* series this year.

Mar. 30: M/R Military Systems Special Issue.

Mar. 31: Air Force sent *Nike-Javelin* in wake of a *Minuteman* launched from Cape Kennedy, to gather data on missile exhaust.

APRIL, 1964

April 1: Further exhaust study conducted when *Atlas-ABRES* launched from Cape carried two passenger pods, one of which ejected backwards into exhaust of *Atlas.*

April 2: Soviet Union launched space probe called *Zond 1.*

April 3: *Atlas F* exploded on launch pad at Vandenberg AFB.

April 4: Soviet Union launched *Cosmos 28.*

April 6: USS Henry Clay launched its first *Polaris A-2* while submerged off Florida coast.

April 6 week: President Johnson ordered removal of NASA's Zanzibar space tracking station, in response to request by Abeid Karume, President of Zanzibar People's Republic.

April 8: AF *Titan II* successfully boosted first unmanned *Gemini* spacecraft into orbit.

April 9: AF launched *Titan II* from Cape Kennedy.

April 12: Soviet Union launched second in *Polyot* series of maneuverable space vehicles, with announcement that it was aimed at perfecting space rendezvous techniques.

April 13: M/R Special Report on Project *Gemini.*

—First Project *Fire* re-entry vehicle launched from Cape Kennedy aboard *Atlas* booster.

—AF launched *Minuteman* from Vandenberg AFB.

April 13 week: Eleven men burned, four fatally, in accidental ignition of *Delta* third stage at Cape Kennedy.

—FCC approved ComSat plan.

April 20: Navy launched two *Polaris A-2* missiles from nuclear submarine Henry Clay off Florida coast.

April 20 week: DOD's new multiple-warhead plan disclosed.

—Joint Atomic Energy Committee warned that failure to flight-test *Tory II* could kill the Pluto program, in reporting out AEC authorization.

April 21: Air Force launched satellite of undisclosed type aboard a *Thor-Able Star* from Vandenberg AFB.

April 23: AF launched *Minuteman* from Vandenberg, AFB.

—AF launched *Atlas-Agena* rocket toward polar orbit from Vandenberg AFB carrying a secret payload.

April 23: AF launched *Minuteman* from Cape Kennedy.

—Another secret AF satellite launched from Vandenberg AFB, on *Thor-Agena* vehicle.

April 27 week: Johnson requested comprehensive report from NASA on post-*Apollo* plans.

MAY, 1964

May 4 week: DOD non-nuclear anti-satellite system revealed.

—Air Force and NASA tentatively agreed on standardized family of launch vehicles for unmanned missions in the 1970's.

May 7: AF launched a *Minuteman* ICBM from Vandenberg AFB.

May 11 week: Thiokol Chemical Corp. dedicated its 260-in. solid propellant plant at Horse Pen Bluff, Ga.

—*Ranger VII* launch date postponed to "third quarter."

May 13: Hot run of Kiwi B-4D nuclear reactor was conducted at Jackass Flats, Nev., with apparent success.

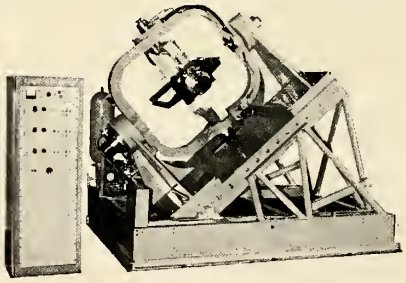
—NASA's *Little Joe II* used to test launch escape system for *Apollo* spacecraft. One of three 88-ft. landing parachutes malfunctioned, but system landed safely.

May 19: *AF* launched *Atlas-Agena* carrying an undisclosed payload.

May 20: Atomic Energy Commission carried out first full-power ground test of Tory II-C reactor at Nevada Test Site.

May 25: Boeing microminiature welder

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won annual M/R new product of the year award for 1963.

—Navy scored successes in initial two firings of the combat *Polaris A-3*. Both were launched from USS Daniel Webster.

—AF launched *Minuteman* from Vandenberg AFB.

May 25 week: Aerojet-General dedicated new large solid booster plant at Homestead, Fla.

May 28: Despite premature shutoff of one of eight 188,000-lb.-thrust H-1 engines, NASA's *Saturn SA-6* put into orbit first boilerplate *Apollo* spacecraft from Cape Kennedy.

—AF destroyed *Athena* missile some 70 sec. after launch from Green River, Utah.

JUNE, 1964

June 1: M/R special issue on electro-optical systems.

June 2: ComSat stock put on sale.

June 4: AF used *Scout* booster to launch secret satellite from Pt. Arguello, Calif.

June 5: Britain launched its *Blue Streak* booster from Woomera, Australia. Primary objectives reportedly achieved despite premature shutdown of engines, causing booster to fall short of target range and speed.

—AF launched another satellite of undisclosed type aboard a *Thor-Agena* from Vandenberg AFB, Calif.

June 8: Navy fired two *Polaris A-3* missiles from submarine USS Daniel Webster, submerged off the coast of Florida.

June 10: USSR launched *Cosmos 32*.

June 8 week: U.S. and Russia agreed to swap data on space biology and medicine work.

June 11: Air Force successfully launched *Minuteman* from Vandenberg AFB, Calif.

June 15: AF launched another *Minuteman* from Vandenberg AFB, Calif.

June 15 week: House Appropriations Committee cut $5.5 million from Pluto nuclear ramjet program, forcing showdown over future of project.

—Air Force signed contracts with three firms to begin four-month study effort into orbital space station experiments.

—House urged tighter control over JPL by NASA, in report on Project *Ranger*.

June 18: Air Force launched two shots from Vandenberg AFB. One, an *Atlas D* traveled 5,000 mi. down PMR; other, a *Thor-Agena*, carried an undisclosed satellite toward polar orbit.

June 22 week: Senate voted NASA $5.246 billion, after amendment to cut 10% from *Apollo* program was narrowly defeated.

June 23: Soviet Union launched *Cosmos 33*.

June 25: AF *Scout* booster exploded with secret satellite at Pt. Arguello.

—NASA's *Centaur* upper stage rocket failed to achieve orbit when RL-10 engines cut off prematurely.

June 30 week: Final NASA authorization bill came from conferees, with only $76.5 million cut from administration request.

—American Institute of Aeronautics and Astronautics held annual meeting in Washington, D.C.

contracts

AWARDS

AIR FORCE

$3,500,000—**Sylvania Electric Products, Inc.,** New York City, for continued work on a cable communications system linking 165 sites for the *Minuteman* ICBM in North Dakota.

$2,675,837—**Trupane Co.,** El Segundo, Calif., for operation of Space Systems Div., Los Angeles.

$1,842,872—**Astrodata, Inc.,** Anaheim, Calif., for a general purpose telemetry data system for use on the Pacific Missile Range.

$91,742—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for an analytical study of feasible systems for missile strike reporting.

$65,964—**Rocket Research Corp.,** Seattle, Wash., for investigation of a high-energy monopropellant.

$65,445—**Conductron Corp.,** Ann Arbor, Mich., for a grid-sphere passive communication satellite.

$64,650—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for an analytical study of feasible systems for missile strike reporting.

$59,810—**Adcole Corp.,** Waltham, Mass., for research directed toward design, development and fabrication of rocket probe instrumentation.

$59,470—**General Dynamics/Astronautics,** San Diego, Calif., for an analytical study of feasible systems for missiles strike reporting.

ARMY

$17,280,157—**Koppers Co., Inc.,** Pittsburgh, Pa., for construction work at NASA's *Advanced Saturn* First Stage Static Test facility project, Hancock County, Miss.

$2,500,000—**Radio Corp. of America,** New York City, for further research and development on the *AADS-70* missile system. **Hughes Aircraft Co.,** Culver City, Calif., also shares in the award.

$1,183,882—**Raytheon Co.,** Andover, Mass., three contracts for retrofit kits, special test equipment and field installation of modification kits for *Hawk* missiles and missile systems.

$415,155—**Collins Radio Co.,** Dallas, Tex., for telemetry acquisition and relay stations with two terminals.

$195,000—**Lockheed Missiles and Space Co.,** Palo Alto, Calif., for an instrumentation package for the *P-11* satellite.

NAVY

$746,199—**Canadian Commercial Corp.,** Washington, D.C., for rocket motors.

$746,199—**Bermite Powder Co.,** Saugus, Calif., for rocket motors.

NASA

$37,145,000—**Hughes Aircraft Co.,** Culver City, Calif., for design and fabrication of a family of *Advanced Technological Satellites*.

$107,130—**Thiokol Chemical Corp.,** Huntsville, Ala., for XM-33E-6 rocket motors.

Westinghouse Electric Corp., Aerospace Div., Pittsburgh, Pa., for design, development and fabrication of a microminiaturized radar altimeter for the *Saturn* launch vehicle.

INDUSTRY

$1,300,000—**Beckman Instruments, Inc.,** Fullerton, Calif., from **Lear Siegler, Inc.,** Santa Monica, Calif., for two data acquisition systems and data processing computers to be used in development of the *Saturn* space vehicle.

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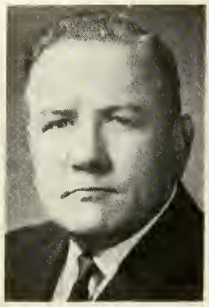
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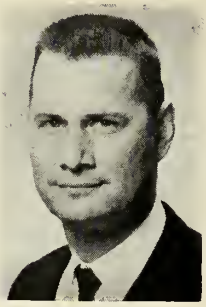
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James E. Fitzsimmons: Established a firm to do consulting work in the aerospace marketing and public affairs field. He was formerly manager of development at Aero Geo Astro Corp., Alexandria, Va.

E. H. Boullioun: Has been made vice president—Missile Branch manager in the Aero-Space Div., The Boeing Co., Seattle. Also named at the same time was **H. W. Neffner**—vice president—director of government contracts for Boeing.

John F. Hughes: Elected vice president of Perkin-Elmer Corp. **Thomas J. Kindilien** was appointed corporate comptroller.

Sidney J. S. Parry: Appointed manager of research and development for Great Lakes Carbon Corp.'s graphite products div.

John L. Gray: Named vice president and general manager of The Battelle Development Corp., a wholly owned subsidiary of Battelle Memorial Institute, Columbus, Ohio.

Harry E. Mottley, Jr.: U.S. Air Force specialist in the field of components and missile system reliability, has joined General Instrument Corp. as corporate director of reliability.

G. J. Monser: Joined Advanced Development Laboratories, Inc., Nashua, N.H., as microwave department manager. He was formerly with Sylvania Electric Products, Inc.

Walter A. Weiss: Appointed vice president and general manager of The Rauland Corp., Zenith Radio Corp.'s cathode ray tube manufacturing subsidiary, Chicago.

Joseph J. Tither: Appointed as managing director of Microwave Associates, Ltd., the wholly owned English subsidiary of Microwave Associates, Inc., Burlington, Mass. He will be responsible for directing operations of the facility.

Four newly elected vice presidents of Beech Aircraft, Wichita, Kan., are **Leroy E. Bowery**—materiel, **Edward C. Burns**—Boulder div., **Roy H. McGregor**—aerospace marketing and contracts, and **Lawrence L. Pechin**—manufacturing.

Frank G. Daleo: Appointed vice president-marketing of Astek Instrument Corp., Armonk, N.Y. He was previously director of marketing.

Richard E. Kelley: Joined American Machine & Foundry Co. New York City, as deputy group executive of AMF's International Group. He was formerly vice president for development and foreign operations of Bell Intercontinental Corp.

John J. Keane: Appointed manager-product development in the Polycarbonate Research and Development Section. Chemical Materials Dept., General Electric Co., Pittsfield, Mass.

John M. Ide: Director of newly-formed division of engineering at the National Science Foundation, Washington, D.C. He was formerly director of SACLANT Antisubmarine Warfare Research Center, La Spezia, Italy.

Joseph P. Villo: Newly appointed eastern regional vice president of Standard Pressed Steel Co.; and **Charles F. Roberts:** Newly appointed western regional vice president.

William C. Fortune: Retired from the Navy after 31 years of service. He will continue in a civilian capacity as manager of Marshall Space Flight Center's Mississippi Test Operations for NASA.

Joseph W. Bearinger Appointed vice president, Chemical and Engineering Associates, Elkton, Md. He was formerly with Thiokol Chemical Corp., Elkton.

Warren T. Rockwell: Appointed director of Washington Operations for Fairchild Stratos Corp. He is also vice president of the new Fairchild subsidiary, Hiller Aircraft Co., Inc.

Milo F. McCammon and L. E. Rasmussen: Elected as vice presidents of The Bendix Corp. They will also become members of the corporation's administration committee.

Joseph P. Grandfield: Appointed vice president-engineering of the Wright-Aeronautical Div. of Curtiss-Wright Corp., Wood-Ridge, N.J.

Louis A. Page: Named manager, public relations, Page Communications Engineers, Inc., Washington, D.C., a subsidiary of the Northrop Corp.

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Seymour Tarras: Appointed general manager and technical director of Chem-Trac Corp., the radiochemistry division of Baird-Atomic, Inc., Cambridge, Mass.

George Snyder: Named vice president-chief engineer of Boeing Company's Aero-Space Div. Also promoted were **Harlowe J. Longfelder** to Snyder's former position as *Manned Orbiting Laboratory* program manager, and **Robert Plath,** who was appointed assistant Missile Branch manager at Boeing.

Hyman Stein: Appointed a scientific supervisor at General Applied Science Laboratories, Inc., Westbury, L.I., N.Y. He is also a member of the NASA Research Advisory Committee on space vehicle aerodynamics.

Paul A. Kinslow: Named manager, advanced developments, in the metallurgical department of the Standard Steel Div. of Baldwin-Lima-Hamilton Corp., Burnham, Pa.

Roger R. Luther: Appointed director, product research and development, of Anchor Coupling Co. Inc., Libertyville, Ill. He will also be administrator in the new Anchor research center.

T. A. Stuart Duff: Appointed chief engineer at U.S. Gauge, a division of AMTEK, Inc., Sellersville, Pa.

James E. Carpenter: Appointed assistant head of the hypersonic tunnel dept. of Cornell Aeronautical Laboratory, Buffalo, N.Y. He also supervises wave superheater operations at the laboratory.

C. W. (Wayne) Quillin: Promoted to vice president in charge of sales and engineering of Bemco Inc., Pacoima, Calif. He was formerly contract administrator for Bemco.

Henry P. Bartle: Joined the Burbank, Calif., Div. of Zero Manufacturing Co. as chief engineer. He will be in charge of administrative engineering as well as supervising systems and instrument packaging projects.

William T. Brown: Joined Cubic Corp., San Diego, Calif., as senior staff engineer in the marketing department.

Maurice A. Garger: Appointed contracts administrator for Greer Hydraulics, Inc., Los Angeles. His major fields of interest are weapons systems and missile propellants.

Elliot J. Siff: Named general manager of the recently formed ACCO Gyro Div. of American Chain & Cable Co., Inc., Waterbury, Conn. He holds several patents in the inertial guidance field and is co-author of a book on gyro instruments.

Andrew Gabor: Elected vice president of Potter Instrument Co., Inc., Plainview, N.Y. He is also director of research and advanced development at Potter.

Robert R. Johnson: Appointed corporate director of engineering-data processing for Burroughs Corp., Detroit. He has responsibility for overall aspects of engineering for data processing products manufactured by the division.

Frank Della Corte: Promoted to corporate public relations manager at Fairchild Camera and Instrument Corp., Syosset, N.Y. His new duties include co-ordinating public relations for the firm's 11 divisions.

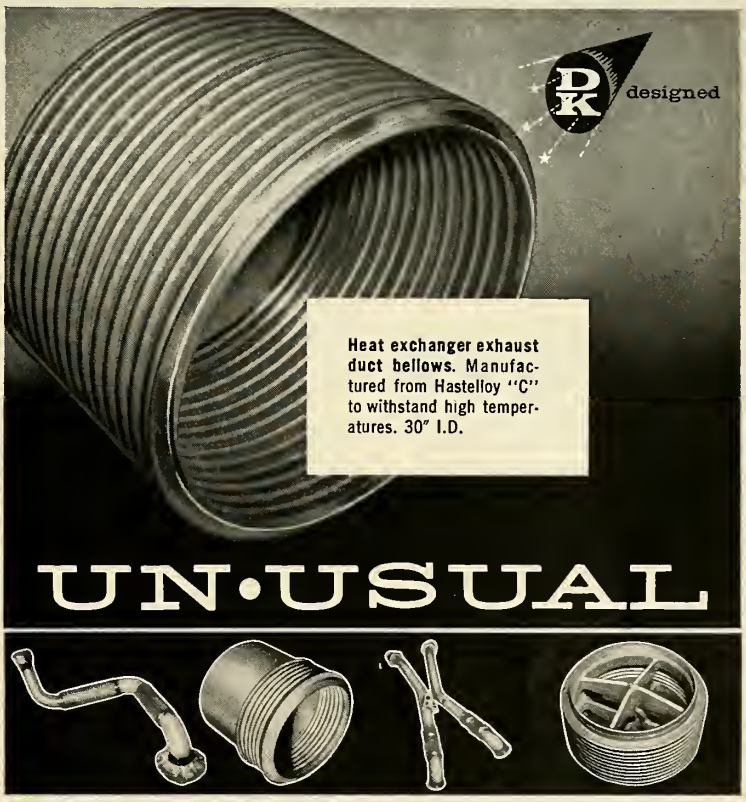
George Q. Herrick: Will take over the newly created position of manager of product development in the Metrics Div. of the Singer Co., Bridgeport, Conn.

William F. Hoffmann: Joined Rocket Research Corp. Seattle, as chief of systems test engineering. Formerly with Boeing, he will now direct instrumentation activities and ground testing of rocket systems.

Thomas D. McGrath: Appointed director of research and development at Waltham Watch Co., Waltham, Mass.

John J. Mahon: Appointed manager of industrial relations for the Albuquerque, N.M., division of ACF Industries, Inc.

Walter E. Seastrom: Named to the newly established post of division administrator in the Control/Nucleonics Div. of Giannini Controls Corp., Duarte, Calif.



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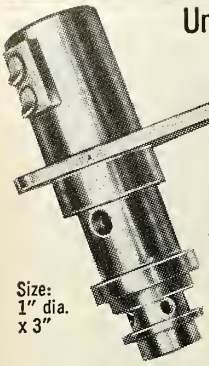
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JULY

"Random Processes in Communication Systems," Polytechnic Institute of Brooklyn's Farmingdale Graduate Center, Farmingdale, N.Y., July 27-31.

AUGUST

First Research Conference on Instrumentation Science, Instrument Society of America, William Smith College, Geneva, N.Y., Aug. 3-7.

Fifth International Symposium on the Reactivity of Solids, International Union of Pure and Applied Chemistry and International Union of Pure and Applied Physics, Munich, Germany, Aug. 4-10.

Performance of Government Contracts Conference, sponsored by Federal Publications Inc. and the Government Contracts Management Assn., Plaza Hotel, New York City, Aug. 6-7.

12th Annual Engineering Management Conference, Institute of Electrical and Electronics Engineers, ASME, AIIE, and ISA, Pick-Carter Hotel, Cleveland, Aug. 9-11.

Seventh National Heat Transfer Conference, American Institute of Chemical Engineers and American Society of Mechanical Engineers, Sheraton-Cleveland Hotel, Cleveland, Aug. 9-12.

Contracts Seminar, Department of Defense and the National Association of Professional Contract Administrators, Orlando, Fla., Aug. 10-13.

Structural Developments in Inorganic Chemistry and their Chemical Implications, AFOSR, New Hampton, N.H., Aug. 10-14.

"Digital Simulation," A five-day course sponsored by Control Technology, Inc., Long Beach, Calif., Aug. 10-14.

Thirteenth Annual Conference of Applications of X-Ray Analysis, Metallurgy Div. of Denver Research Institute at the Univ. of Denver, Albany Hotel, Denver, Aug. 12-14.

1964 Cyrogenic Engineering Conference, University of Pennsylvania, Philadelphia, Aug. 12-14.

Elementary Nuclear Magnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 17-19.

Tenth International Symposium on Combustion, Combustion Institute and Cambridge Physical Chemistry Dept., Cambringe University, Cambridge, England, Aug. 17-21.

International Astronomical Union Symposium No. 25, AFOSR, International Astronomical Union, Government of Greece, and University of Thessaloniki, Thessaloniki, Greece, Aug. 17-22.

Ninth Annual Showing of Advanced Electronic Research Projects, sponsored by Stanford Electronics Laboratories, Stanford University, Stanford, Calif., Aug. 18-21.

Elementary Electron Paramagnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 19-21.

Conference on Interference and Coherence, International Commission for Optics and Australian Academy of Sciences, Sydney, Australia, Aug. 24-25.

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, Aug. 24-26.

Fourth Congress of the International Council of the Aeronautical Sciences, International Council of the Aeronautical Sciences and AIAA, Paris, Aug. 24-28.

Ninth Annual Technical Symposium, Society of Photo-optical Instrumentation Engineers and USAF Eastern Test Range, Deauville Hotel, Miami Beach, Fla., Aug. 24-28.

"Graphic Techniques for Computation," sponsored by the Univ. of California Extension Center, San Francisco, Aug. 24-Sept. 4.

Western Electronic Show and IEEE Summer General Meeting, Biltmore Hotel, Los Angeles, Aug. 25-28.

12th General Assembly, International Astronomical Union, University of Hamburg, Hamburg, Germany, Aug. 25-Sept. 3.

Gravity Day, sponsored by the Gravity Research Foundation, New Boston, N.H., Aug. 29.

148th National Meeting, American Chemical Society, Chicago, Aug. 30-Sept. 4.

69th Summer Meeting, American Mathematical Society, Amherst, Mass., Aug. 30-Sept. 4.

Eleventh International Congress of Applied Mechanics, sponsored by the International Council for the Congress of Applied Mechanics, Deutsches Museum, Munich, Germany, Aug. 30. Sept. 5.

Electric Propulsion Conference, AIAA, Bellevue-Stratford Hotel, Philadelphia, Aug. 31-Sept. 2.

45th Summer Meeting, sponsored by the Mathematical Assn. of America and the American Mathematical Society, Univ. of Massachusetts, Amherst, Aug. 31-Sept. 2.

Third Geneva Conference on the Peaceful Uses of Atomic Energy, sponsored by the United Nations, Geneva, Switzerland, Aug. 31-Sept. 11.

SEPTEMBER

Third Biennial Aerospace Power Systems Conference, AIAA, Bellevue-Stratford Hotel, Philadelphia, Sept. 1-4.

Meeting of the International Commission for Optics, Tokyo and Kyoto, Japan, Sept. 1-8.

Twelfth Annual Engineering Management Conference, sponsored by IEEE, ASME, AIIE, ASCE, and others, Pick-Carter Hotel, Cleveland, Sept. 9-11.

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The World Ahead

THE TITAN II on the cover of this annual encyclopedia issue is symbolic of the metamorphosis taking place in the missile/space industry. Designed by the Martin Co. as an intercontinental ballistic missile, *Titan* is shown on the cover in its new role as booster for the *Gemini* spacecraft.

Even as the *Gemini* program gets under way, *Titan III* is being groomed on a launch pad at Cape Kennedy for its maiden flight. It soon will take its place in the stable of standard launch vehicles.

Further evidence of this transition from weapon to space booster is seen in the almost routine manner with which the *Atlas* continues to perform these days as a basic launch vehicle for a multitude of payloads.

Thus, expensive investments in the military defense of the United States are beginning to pay dividends in the nation's peaceful space program. A mushrooming list of weather, navigation and communications satellites, with particularly significant new entries from the Communications Satellite Corp., is recorded in this year's encyclopedia.

We see once again the historic pattern of investment in military projects paying off in useful, productive devices for the civilian economy. The same type of fallout which saw early military sponsorship of aircraft lead to widespread development of civil aviation is being repeated in space.

All too often those who seek industrial fallout from the government space projects, including those both of the military and of the National Aeronautics and Space Administration, search with too small a microscope. Efforts to identify industrial use of a space-developed material or product are laudable. But at this early date in the Space Age, these benefits are minor.

The search must be conducted on a much broader scale.

The study of commercial benefits from the space program which Denver Research Institute recently carried out for NASA made this clear. The investigation turned up a number of specific product examples. But the Institute reported something of far greater significance in its conclusions.

It said: "Relatively little importance can be attached to the direct transfer of *products* from missile/space programs to the civilian sector of the economy at this time. . . . The findings lead to the conclusion that *product* transfers have not been significant. . . . It is more accurate and meaningful to consider missile/space contributions to the commercial sector of the economy in terms of the transfer of technology rather than in terms of a transfer of products."

DRI identified 13 broad technological areas in which such a transfer has taken place—instrumentation, control systems, power sources, fabrication, electronic components, materials, medical technology, propulsion, plasma dynamics, telemetry and communications, vibrational testing, management and control, and packaging and shipping.

In an industrial economy such as ours, this assuredly is a major contribution. But the value of the space program does not stop even there.

As NASA Administrator James E. Webb points out in the June issue of *Astronautics and Aeronautics:* "We can measure the cost of a telephone connection made by undersea cable against one established by a communications satellite, but we cannot begin to measure the potential value to mankind of a system of future synchronous satellites linking all the countries of the world in a live television and radio network. It is possible to believe that the climate of world opinion created by the very existence of this bond among the peoples of Earth will in the long run be very good for world business and commerce and America's domestic and international interests and well being."

Martin Co. president William B. Bergen described to the National Space Club last week what this can mean. He said: "I am convinced, hardwarewise, we are well prepared to go places and do things in space. What we need to do now is to get on with the job—and keep on with it. We will, of course, develop more effective and less costly boosters and spacecraft as time goes on—just as we developed better and better airplanes over the years after the Wright Brothers put together and demonstrated the initial hardware to solve man's age-old quest for a means to achieve heavier-than-air powered flight for himself and his descendants. We have gone a long way in the air since the Wrights and I, for one, believe we are going an equally long way, comparatively speaking, on the newly blazed trail into space."

Mr. Bergen described for his listeners Martin studies into fully maneuverable lifting-body craft capable of landing at any U.S. air base in the world upon their return from space. He reported Martin conclusions that recoverable launch vehicles, in which each stage of the booster is equipped with appropriately designed wing surfaces, landing gear and a crew of its own to fly it home, offer a feasible plan of better cost/effectiveness on the launch pad.

"Martin already has done enough research on this method of booster recovery to feel sure it can be accomplished successfully," he declared.

Thus, tomorrow's planning already is well advanced. And as former Dept. of Defense official John Rubel has said: "Perhaps this new-found ability to combine a great diversity of scientific and technical skills and disciplines to make a massive assault on very large-scale problems will turn out to be a social invention of even greater consequence in the long run than the scientific and technical innovations on which most attention is focused."

QUITE SO. Just as an effort to extrapolate a 1964 airline map of the world from the Wright Brothers flight would have been impossible, so must today's attempts fail to assess the real potential of the Space Age. But, just as surely, it is there.

William J. Coughlin



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For more of the Vickers story, write for Bulletin A-5283A. Vickers Incorporated, P.O. Box 302, Troy, Michigan.



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Crown Compass (Danish—circa 1790)—Courtesy The Trustees of the National Maritime Museum, Greenwich, England

from crown compass to missile guidance

"Surely oak and threefold brass surrounded his heart who first trusted a frail vessel to the merciless ocean," wrote Horace 2,000 years ago. Twelve centuries passed, and a dread of the sea was still part and parcel of every sailor's kit. Then someone discovered the directive properties of a magnetized needle. The mariner's compass was born; and with it came the means to set a course at sea without fear.

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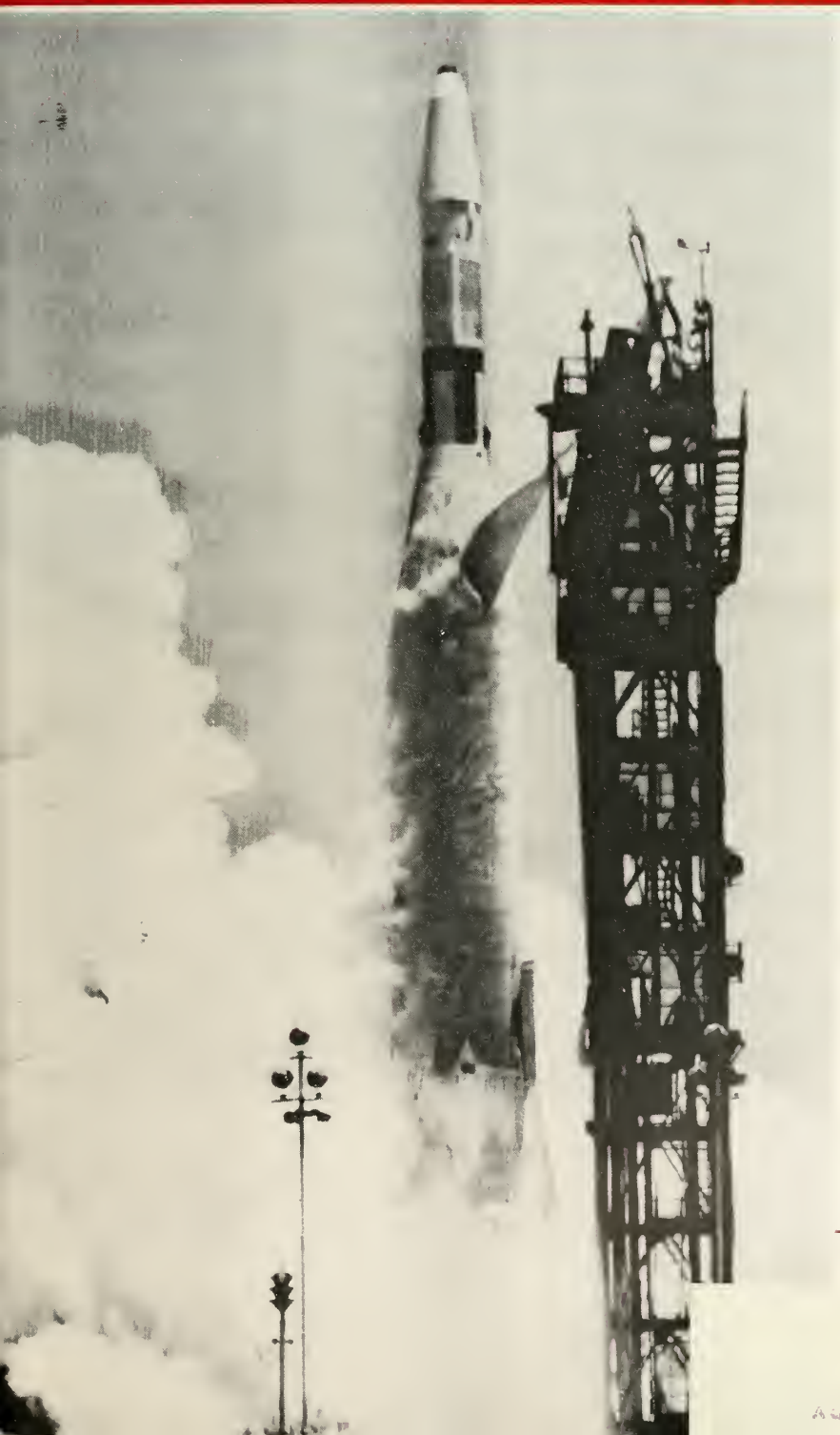
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AUGUST 3, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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Debate Over Pace Slows Development of Antitank Missiles

Ranger VII Zeroes In on the Moon

LBJ Announces SR-71 Aircraft

How Bullpup Costs Have Been Cut

Ranger VII Lifts Off

A SPERRY MANAGEMENT REPORT



Technical Management to order. Space instrumentation calls for kid-glove handling, *by* specialists. The team elected to support the instrumentation of space programs should be able to operate, maintain, checkout, and test the gear without outside help. They should be able to *modify* it, as needs and targets change. They should be able to *repair* it when it breaks down. For all of this, they need solid experience and good fundamental knowledge in tracking, timing, telemetry, computer technology, radar, and communications. ☐ The Sperry team has the experience and the specialized skills in defense/space instrumentation... in field engineering... in working with government agencies... and in management capability demonstrated in many areas of ever greater responsibility... to do the job. **General Offices: Great Neck, New York.**

SPERRY

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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 15, Number 5 August 3, 1964

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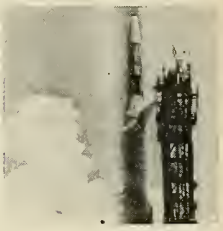
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President.....Wayne W. Parrish
Senior Vice President.....Louis C. James
Vice President.....Fred S. Hunter

THE COVER



Atlas-Agena bearing Ranger VII spacecraft lifts off from Cape Kennedy July 28. Mid-course correction executed July 29 apparently put the NASA/JPL lunar hardlander on a course that would allow its cameras to take the first U.S. pictures of the Moon's surface. *See story, p. 13.*

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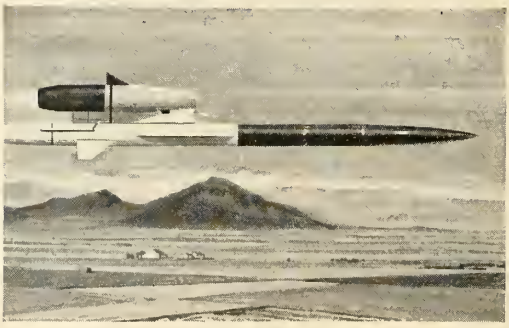
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This is the only target missile that can provide realistic training for the Hawk air defense missile. It is the versatile Redhead/Roadrunner official U.S. Army Hawk target.



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North American Aviation Columbus Division

4300 East Fifth Avenue, Columbus, Ohio

Survival of the Fittest

To the Editor:

Your recent editorial, "Survival of the Fittest" (M/R, June 29), was well-taken and exceptionally well-timed. It should serve as a challenge and a beacon to all who are in the aerospace industry. It should be required reading for all who have been demanding, in effect, subsidies for that industry.

This editorial and Mr. Tyminski's meaty, splendid advice are in generally the same vein as Dr. Fubini's warning against "gloom and doom" talk as reported by you in a recent issue. We should, however, consider all of these remarks and advice in the light of other official, semi-official, and civilian remarks such as those made at the recent briefing of the American Management Association. These remarks have been reported by you and ably commented upon by you in your July 20 issue.

Again, thank you for your splendid editorial.

Milan G. Weber
President
The Milan G. Weber Associates
Deerfield, Ill.

False Soviet Claims

To the Editor:

Dr. Killian's report "Toward Better Utilization of Scientific and Engineering Talent" is timely and thought-provoking. The alleged numerical superiority of the USSR in scientists and engineers is meaningless because we do have the best scientists and engineers as attested by our record of technological accomplishment.

The Soviet technological challenge is formidable at the present time *only* because we tend to overcomplicate and duplicate excessively while they avoid duplication and stress simplification without impairment of function. Our immediate need for countering the Soviet challenge is the compulsory registration of all American scientists, engineers and inventors with documented records of advanced concepts in the form of published articles, patents and patent applications, and the systematized deployment and utilization of such personnel in major projects which *nust* include the high-priority national needs of lunar landing and supersonic transport projects; and as emphasized by Dr. Killian, management *nust* be very competent technically and not merely administrative.

The confusing political interest in many American scientific projects has obscured the fact that some Soviet developments are based on American basic concepts. In "Russian Science in the 21st Century," published by McGraw-Hill, the Russians claim a new electronic plasma system for drilling and boring through rocks and mountains; and automatic automobiles in the year 2007 operated by an electromagnetic field through induction from an underground cable. These claims are questionable. Prior to 1905 Werderman devised an electric blow-pipe for boring holes in rocks comprising a voltaic arc and an electromagnet for deflecting the arc; and as can be seen on page 398 of the October, 1917, *Electrical Experimenter* I am the inventor of the "Inductive Cable Guidance System," which the Soviets claim as an advanced concept for the year 2007.

Harry Bricker Fuchs
Farmingdale, L.I., N.Y.

Decaying Patentry

To the Editor:

Always much interested in patentry, I would like to comment on "Independent Inventor" and "Why Organized Inventors?" in your recent letters columns—because these are pertinent to the review and recommendations of the ills of our decaying patent system by the ad hoc Patent Panel of the Department of Commerce, of which I am one of the dozen appointed members, and the grantee of some 200 U.S. and foreign patents as an independent inventor.

B. McFarlane was completely justified in his criticisms of the patent fees bills now before Congress, and the sense of our panel is in agreement although, and curiously, Mr. Hollomon, Assistant Secretary of Commerce for Science and Technology, testified strongly in behalf of S.2547 and HR 8190. the bills in question.

But not so curious is the fact that Mr. Hollomon is a former top executive of the General Electric Co., one of the first originators of the patent-assignment employment contracts, about which Mr. Bloomer rightfully complains, and which our Panel recommends be abolished because they destroy creative incentives, so successfully applied by legislation in European countries.

There is, however, much to be said about the problem of high patent attorney fees and the legal argot of our patent system, which has made them an even greater obstacle to independent invention that the statutory fees of the Patent Office. I also agree with contentions about the patent courts, where lawyers, naive in technology, hear patent cases. Reforms here also have been long advocated by the Patent Equity Association, of which I am president.

For those who are concerned about the increased normal and new patent-maintenance fees, I suggest that they write their Congressional representatives for a copy of "Patent Office Fees," on hearings on S. 2547 and HR 8190 by the McClellan-chairmaned Subcommittee of the Judiciary, U.S. Senate, 2nd Session, 88th Congress, Feb. 27-28, 1964.

B. F. Miessner
Miami Shores, Fla.

Six-Month Index

AN EDITORIAL INDEX of the articles appearing in MISSILES AND ROCKETS during the first six months of 1964 is available to subscribers free of charge.

Requests for copies should be addressed to:

Research Department
Missiles and Rockets
1001 Vermont Avenue, NW
Washington, D. C. 20005

Project SCORE

To the Editor:

The article on page 28 of the June 15 M/R states that *Courier* was the nation's first active-repeater communication satellite.

For your information—Project *SCORE* communication satellite, for which RCA developed the communications equipment under the direction of the U.S. Army Signal Research and Development Laboratory (now part of Army Electronics Command), was launched into orbit on Dec. 18, 1959. On the next day, *SCORE* relayed the world's first message from outer space. This, of course, was President Eisenhower's Christmas message.

M. G. Staton
Manager, Marketing
Radio Corporation of America
Astro-Electronics Div.
Defense Electronic Products
Princeton, N.J.

The Project SCORE shot (M/R, Dec. 29, 1958, p. 13) was the first successful multi-channel teletype transmission by the delayed repeater technique on a ground-satellite-ground relay system.—Ed.

On 'Instant Peace'

To the Editor:

I hope that your magazine and others in the missile/space field will continue and intensify efforts to point out the futility of suggestions that the aerospace indusry should "convert" to other forms of R&D and manufacturing.

Already the leader of one of the major political parties has stated that he considers that the Moon race is being overemphasized. Perhaps we will hear the other shoe drop at Atlantic City.

I fear that a goodly number of our political figures (hopefully still a minority) don't realize these salient facts: 1) the space program is essential to both national prestige *and* adequate defense; 2) the program will yield technological progress that cannot be achieved over a comparable range of time in any other way; and 3) heavy cutbacks in the effort would imperil the vitality of the entire U.S. economy.

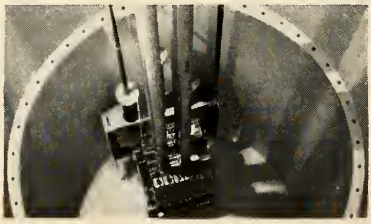
Greg Hawkins
Houston, Tex.



Lockheed-Georgia helps AEC demonstrate the peaceful atom around the world

Bogota, Buenos Aires, Rio. Mexico City, Montevideo, Lima, and Santiago. Vienna, Belgrade, Madrid. This has been the itinerary of the Atomic Energy Commission's Atoms at Work exhibit to demonstrate the peaceful uses of nuclear energy to our friends in other parts of the world. More nations on both sides of the Atlantic are slated to see it in the near future.

The heart of the AEC exhibit is a 10-kilowatt training and research reactor built by Lockheed-Georgia. It is a pool-type radiation facility similar to the reactors Lockheed has built for use in the U.S. and South America. In the world tour, the reactor is used for production of short-lived isotopes to demonstrate medical and physical research to scientists, engineers, and educators.



Lockheed-Georgia Company

Lockheed-Georgia Company, Marietta, Georgia: A Division of Lockheed Aircraft Corporation.

The Countdown

WASHINGTON

Army Preparing MAW Requirements

Development of the Army's *Medium Anti-Tank Weapon* is expected to get under way sometime next year. The service now hopes to have its requirements outlined by early spring. The weapon, with a range of about 1,000 yards, will fill the gap between M-72 and *TOW*.

All Systems Go for Titan III

Commander of the Air Force's Space Systems Division, Maj. Gen. Ben I. Funk, says *Titan III* is within 60 days of flight test, with AF fully confident that the second and third stages will be completely operable. All three stages—and all guidance and control systems—are to be functioning from first flight onward. Initial *Titan III-A* flight is set for mid-September at Cape Kennedy.

Hornet System Looks Promising

An unsolicited missile proposal from North American's Columbus Division, funded for $600,000 by the Air Force Special Warfare Center—may well see full development. *Hornet* is being tested at Eglin AFB under close appraisal by Dept. of Defense. Reports are enthusiastic. The aircraft-launched missile is designed to destroy tanks. Secret is use of thrust, rather than a shaped charge, to achieve penetration.

A-7 Will Carry Wide Missile Variety

Ling-Temco-Vought's A-7 (VAL) aircraft will be capable of carrying a dozen Mark 81 *Snakeyes*, a weight of some 3,800 lbs. The new Navy plane, set to go operational in 1967 after first flight in late 1966, also will be equipped for *Zuni*, *Sidewinder* and *Walleye* TV-guided missiles.

NASA Seeking Lab Support

Marshall Space Flight Center has issued the first of a series of Requests for Proposals for technical and engineering support services for its laboratories. First RFP—for support of the Center's test laboratory—has been sent to 45 missile/space firms. Bids are due by Sept. 15.

Ranger Clears Way for OGO

Launch of *Ranger VII* clears the way for launch of the *Orbiting Geophysical Observatory* from the same *Atlas-Agena* pad early in September. Had the *Ranger* shot slipped, NASA was ready to drop the *OGO* flight so *Ranger* could be scheduled in the September window.

Rendezvous Pod Scrubbed for GT-4

Rendezvous pod has been dropped from the *Gemini-Titan 4 (GT-4)* flight. It will be replaced by a radiation experiment. NASA also has announced that Christopher C. Kraft, Jr., will be flight operations director for the second *Gemini* flight, in October. Kraft currently is assistant director for flight operations at Manned Spacecraft Center.

Miller Will Try Again

Contrary to one published report, Rep. George Miller (D-Calif.) will seek re-election this fall. If successful, he will return as chairman of the House Science and Astronautics Committee—assuming the Democrats control Congress. On the same assumption, Miller's defeat would put Rep. Olin "Tiger" Teague (D-Tex.) at the helm.

The Moon in June—Er, July

Among those set to watch *Ranger VII's* view of the Moon from ringside at Jet Propulsion Laboratory was Rep. Joseph Karth (D-Minn.) Karth was chairman of the NASA Legislative Oversight Subcommittee which was critical of JPL in its recent inquiry into previous *Ranger* failures.

INDUSTRY

NASA Looks at Titan III

Air Force has asked NASA to determine whether the space agency has any possible payloads for the *Titan III* booster. Now, after two months of study, agency officials say they have found no payloads which haven't already been committed to NASA boosters. A report to this effect will be made to the launch vehicle panel of the Aeronautics and Astronautics Coordinating Board in about a month. Dept. of Defense decision to go ahead with a military communications satellite program was a hopeful sign for *Titan III* contractors, however.

Extended Apollo Study Extended

North American Aviation has received a $700,000 extension of its contract study of the *Extended Apollo* spacecraft. The capsule—high on the list of future programs in the Office of Manned Space Flight—would be used for extended lunar exploration and as an orbiting space laboratory. Contract extension covers six months.

AMF Group Moves—As Expected

American Machine and Foundry Co.'s Advanced Products Group—the firm's principal defense, space and nuclear organization—has moved its headquarters and staff operation from Greenwich, Conn., to Washington, D.C. The relocation completes the transfer of the company's engineering and development functions from Connecticut. The Atomics Division and the General Engineering Division, both formerly in Connecticut, recently were moved to the firm's newly acquired plant in York, Pa. COUNTDOWN's report last year (M/R, Dec. 16, p. 9) that the group would be pulled out of its Connecticut facilities was denied by AMF officials at that time (M/R, Dec. 23, p. 9).

INTERNATIONAL

Further Details Given on ELDO Plans

West German space official Rolf Engel has given more details of *ELDO* satellite planning during a visit to Woomera, Australia. He says first launchings of the European satellites in 1967 will be into low 300-mi. orbits. By 1968 or 1969, it is expected that Woomera will be launching the satellites into 7,500-mi. orbits. Launchings will be to the north or northeast.

Expansion of MLF Is Studied

Delegates from the U.S. and seven European nations have met in London to study Britain's proposal for expanding the Multi-Lateral Force from a purely naval group to include aircraft and missile forces. Under the plan, MLF also would be equipped with British TSR-2 and U.S. F-111 (TFX) aircraft armed with air-to-ground nuclear missiles. Crews of mixed nationalities also would be provided for *Pershing* missiles already based in Europe.

Titan III Payloads Identified

Nine payloads have been listed as passengers aboard research and development flights of the *Titan III* space booster. Five of these are experimental communications satellites built by MIT's Lincoln Laboratories; a sixth is a back-up comsat also from Lincoln Labs, and the remaining three are scientific satellites utilizing the modified *ARENTS* spacecraft shell.

To avoid confusion with the defunct *ARENTS* program, the latter spacecraft have been re-named *Orbiting Vehicle 2 (OV-2)*.

Two of the communications satellites will be launched into medium altitude circular orbits, one in a 4,000-mi. elliptical orbit and two into synchronous orbit. The first *OV-2* spacecraft will be launched into an elliptical orbit with a perigee of 100 mi. and an apogee of 4,000 mi.; the second will be launched in tandem with a synchronous comsat and the third will be put into a 260-mi. circular equatorial orbit. Northrop's Space Laboratories are modifying the *ARENTS* spacecraft for the *OV-2* program.

The first live payloads will be carried on the third launch of the *Titan IIIA* with the "C" configuration being used to achieve the synchronous orbit with the tandem payload. All nine satellites are designated "high risk" payloads since flight objectives of the *Titan III* take priority over the satellites.

McKee Gets NASA Post

Gen. William F. McKee, deputy Air Force Chief of Staff, has been appointed assistant NASA administrator for management development effective after his retirement from the Air Force Aug. 1.

Prior to coming to Washington in July, 1962, to his present post, McKee was commander of the Air Force Logistics Command at Wright-Patterson AFB, an assignment dating from August 1961. Before taking over that post McKee did an 8-year tour as vice chief of the Air Materiel Command.

Congress Clears Contractors

Defense contractors will get no immediate repercussions from their "welfare and recreation" expenses, which were questioned by a Congressional investigating committee (July 30, p. 26).

Subcommittee chairman Porter Hardy (D-Va.) assured contractors that everything brought out during the three days of hearings was legal under current Armed Services Procurement Regulations (ASPR). If some of the practices are concluded to be unallowable on Government expense account, it will be the fault of the ASPR's, he indicated.

Committee sources said that the group is now going over the testimony, and a report will probably be forthcoming in the next three or four weeks.

Shots of the Week

Ranger VII was launched July 28 from Cape Kennedy (see story, p. 13).

- The official Indonesian news agency, Antara, has reported that country recently launched the first rocket manufactured in Indonesia. The single-stage missile is for use against tanks and aircraft.
- Japan launched its first weather observation rocket July 22 from the National Space Development Center testing ground on Niijima, 100 mi. south of Tokyo. The 25-ft.-long rocket was manufactured by Mitsubishi Heavy Industries.
- The Air Force successfully launched two missiles in as many days from Vandenberg AFB, Calif., July 28 and 29. The first was a *Minuteman* ICBM, the second, an *Atlas*.
- Air Force Capt. Joe Engle flew the NASA-Air Force *X-15* rocket plane from Edwards AFB, Calif., July 29 in a test of the heat-resistant qualities of materials used on the craft's fuselage.

McDivitt, White GT-4 Crew

Astronauts James A. McDivitt and Edward H. White II, both Air Force captains, will make the second manned flight of the *Gemini* space ship.

They became the first "assigned" pilots picked by Donald K. (Deke) Slayton, chief of astronauts and deputy director of the Manned Spacecraft Center. MSC officials said they plan the McDivitt-White launching "in the first quarter of next year."

McDivitt and White will follow Virgil I. Grissom and John Young (prime crew for *GT-3*), whose flight is still scheduled for the last quarter of this year.

The *GT-4* crew was picked, Slayton said, on the basis of their appearing to work easily and naturally together. Evaluation of the men's probable compatibility during four days in space came from training officers who worked with the astronaut corps.

McDivitt and White have known each other since 1958 when they were students at the University of Michigan. They both graduated in 1959, McDivitt receiving his bachelors degree in aeronautical engineering and White, a West Pointer, taking his masters.

Slayton said the caliber of the astronaut pool made it "difficult to separate one from the other: on the basis of readiness for a particular flight alone." He said the training personnel watched for natural groupings of two and three men.

Slayton said the time had passed when the "best pilot" status governed the choice of a crew.

Boeing Gets M/R Citation

The Boeing Co. has been awarded MISSILES AND ROCKETS' annual New Product of the Year Award for its development of a microminiature welder (M/R, May 25, p. 39).

Dr. Edward C. Welsh, executive secretary and acting chairman of the National Aeronautics and Space Council, presented the award to William Marsh and Al Barstow of Boeing on behalf of M/R at a Washington luncheon last week.

Kollmorgen Corp. and Control Data Corp. received Awards of Honor, Kollmorgen, for a compact pointing interferometer, and Control Data, for that firm's 6600 Computer.

A third Award of Honor was presented to Conductron Corp. last month by Governor George Romney of Michigan.

NATO To Get Nuclear Secrets

Closed hearings began last week on the proposed agreement with North Atlantic Treaty Organization (NATO) countries, which would give them access to certain U.S. atomic weapons secrets.

The agreement proposed by the President and supported by the Secretary of Defense, Secretary of State and Atomic Energy Commission

chairman, will automatically be considered approved by the Congress if no protest is raised within 60 days.

The Joint Committee on Atomic Energy said it will hold public hearings in August on the same subject. Witnesses at both sessions will include top officials from DOD, AEC and the State Department.

RAF Missiles in Malaysia

Britain has installed *Bloodhound* ground-to-air missiles at RAF bases in Malaysia.

The missiles, described as "purely defensive," have "very successfully" met static test requirements, according to the RAF.

NASA Fund Decision Near

NASA's final fiscal fortunes should be settled shortly when the Independent Offices Appropriation bill goes to the Senate early this week.

However, the final figure will remain a mystery until the end because of a quirk in which the House did not act on the bill because the authorization had not been passed at the time the Independent Offices Appropriation was brought up.

For this reason, the Senate subcommittee voted to leave the bill at the requested amount of $5,368,506,000. Thus, when the House and Senate conference takes place, almost any figure could conceivably emerge.

However, some attempt to limit the Senate figure below the top amount is expected when the Senate considers the bill. Last year, the Senate voted to cut the bill by almost $100 million below that recommended by the Appropriations Committee.

Army To Hold Industry Briefing

Aerospace industry representatives have been invited to attend a classified briefing sponsored by the U.S. Army Missile Command on future plans for Army missiles.

The one-day program, an advanced briefing for industry, will be presented to different groups on each of three days. Approximately 100 aerospace industry executives have been invited to atttend each of the sessions on Aug. 10, 11 and 12.

Other agencies of the Army and DOD have been invited to send representatives. The Missile Command planned the program to keep a group of attendees at each session at a reasonable size in order to be more responsive to the information needs of individual companies.

The program, arranged by the Missile Command's Directorate of Research and Development, will be the first sponsored by an Army agency since the Defense Dept. told the services to provide such briefings to industry. An earlier plan by the DOD to provide to industry in Washington all service briefings on material plans had to be abandoned when facilities proved inadequate to handle all those who applied.

Each of the Missile Command sessions will include classified presentations on missile development objectives and goals for the Army of the 1970's as well as detailed information on the Command, research and development program structure, and its research programs. Time has also been scheduled for industry questions and a panel discussion by key personnel of the Missile Command.

Hector Skifter Dead

Dr. Hector R. Skifter, president of Airborne Instruments Laboratory of Cutler-Hammer, Inc., and former assistant director of defense research and engineering, died last week in New York of a heart attack.

Skifter was once chairman of the Ballistic Missile Defense Steering Group, in which capacity he headed the installation of the BMEWS system and coordinated the planning for development of the *Nike-Zeus* and ARPA Defender programs.

Poland, Egypt Show Missiles

BELOW: Communist Poland parading Russian-built tactical missiles in Warsaw July 22. RIGHT: Egypt included these Soviet-supplied SAM-2 antiaircraft missiles in a Cairo parade viewed by visiting African heads of state July 23.





Army Presses for Tank Killer

Stricom commander wants superior weapon not dependent on problems associated with tracked-vehicle systems

by James Trainor

THERE ALREADY ARE plenty of ideas for providing the Army with an adequate antitank weapon, but opinion as to how fast these ideas should be implemented varies widely within the Army and the Dept. of Defense.

Development agencies want to push forward as fast as possible, while Pentagon echelons insist that, in a peacetime environment, all of the *pro forma* requirements be met—including operational analyses, component development and feasibility demonstration, pre-project definition and project definition.

Meanwhile, field commanders are desperately looking for a weapon that will fulfill their needs. Most outspoken is Gen. Paul D. Adams of Strike Command (Stricom) who wants "an antitank weapon which could eliminate our present-day dependence on the tank and free us from its inherent disadvantages of strategic immobility and heavy logistical support requirements and at the same time enable us to cope with the massive Communist tank formations."

Development of a superior antitank weapon, he stressed, would have as great an impact on warfare as any development which has taken place during this century.

None of the weapons now in use or under development come close to meeting this requirement, it is readily admitted with varying degrees of candor by everyone involved in the antitank problem. However, there the consensus ends. In the field, development agencies feel they can meet Adams' requirement with today's technology. In Washington, neglecting the obvious fact that Stricom is a mobile fighting force which could be engaged in combat at any time, both military and civilian officials insist on adherence to an "orderly," "balanced," "adequate" program which will satisfy the General Accounting Office. One official cited GAO's criticism of the Korean War decision to rush the M-48 tank into production before completion of its engineering tests as an example of what must be avoided in this "peacetime" environment.

● **Promising approaches**—In one of the most heavily censored speeches at the Aviation and Space Writers Convention in Miami this May, Maj. Gen. John G. Zierdt, commanding general of the Army Missile Command, listed two major requirements for antitank weapons:

—"In the direct-fire role against a tank . . . you need to get out there fast. Point and shoot. We need propellants with very high burning rates and some solutions for the structural and aerodynamic problems caused by the terrific velocities such propellants produce."

—"An out-of-line-of-sight capability against tanks and other hard targets. The more elementary solution would involve an observer who had the target within his vision and some means of homing in a missile on call. The other would be a completely out-of-sight capability in which we could, for example, fire a missile from one side of this building, send it over the roof and tell it to bite the first tank it found on the other side."

Zierdt's speech, which took 28 days to get cleared in the Pentagon, did not elaborate on systems to solve these problems; several are available, however. First, the requirement for high speed is being investigated through a hypervelocity program at the Ballistic Research Laboratories, Aberdeen, Md.

One of the hypervelocity studies is a program called Arbalest, which was undertaken by Douglas Aircraft Co. with propulsion by Thiokol Chemical Corp. Some 40 test rounds were delivered to the Army for $1 million and are being fired at Aberdeen. Those associated with the program are enthusiastic; they report that a predictable, repeatable bias has been obtained in the firings. The high-energy propellant burns at a rate of approximately ½ in./sec. Army Pentagon officials claim, however, that they are no longer interested in the program and it is no longer being funded.

Primary problems with hypervelocity weapons are protection of the gunner, structural materials and kill mechanisms. Army development officials do not see any of these problems as insurmountable, however. One-shot (or one-time) correction could be used to direct a high-speed missile to its target after ejection by a lower-energy propellant.

Sprint and Advanced Research Projects Agency propellant programs have direct and important spinoffs to hypervelocity direct-fire antitank weapons, according to an Army official.

Ballistic missile defense programs also have important application to semi-active and indirect fire weapons, particularly in sensor technology and discrimination techniques. One of the most exciting prospects in this area is the use of a target-illuminating device, such as a laser beam or infrared or ultraviolet sensors, for discrimination and employing a missile fired from the rear to home on the illumination. This would eliminate any tell-tale back-blast from a recoilless front-line weapon and increase first-shot kill probability.

Another approach is a radar-guided missile. Although extensive work is being done in this field, the problem is killing a non-moving tank.

To meet the indirect-fire requirement, Army development agencies feel that adaption of the *Walleye*-type TV contrast system is the best approach. Techniques exist, they say, to move the aiming point of the missile from the edge of the target to its centroid. Interest is also expressed in the use of IR and UV homing systems coupled with metallic-object detectors. The problem with the latter systems, they say, is that there is no way of discriminating between a live and dead tank. "We don't want to keep on killing the same tank," one official says.

● **Current developments**—At present, the Army has requirements for a family of antitank weapons. They range from the light antitank weapon with a range of 500-600 yds., fired by the individual soldier, to the medium antitank weapon with a range of 1,000 yds., to the heavy weapon with a range of 2,000 yds. *TOW* is currently under development for the heavy weapon role, but there are no development programs in the other two categories. The M-72 is presently filling the light weapon role but is considered inadequate to the task. The French *SS-10/SS-11/ENTAC* are also in use but will be replaced by *TOW*.

Shillelagh is not a member of this family and is being developed for armament on the Sheridan armored assault and reconnaissance vehicle. It is credited with "fantastic accuracy" and reported to be ready for volume production. ■

Favoring Army philosophy. . .

President Discloses Development of SR-71 Mach 3 Reconnaissance Plane

Lockheed aircraft to be flight-tested early in 1965, would be used to direct follow-up ICBM attacks on enemy targets

A SPOTTER AIRCRAFT to direct ICBM fire on enemy targets has been announced by President Lyndon B. Johnson. The Mach 3 aircraft was described by the President at his news conference July 24 as "a long-range advanced strategic reconnaissance plane for military use, capable of world-wide reconnaissance for military operations."

The SR-71 is built by Lockheed Aircraft Corp. and is powered by the same J-58 engines used on the supersonic YF-12A (A-11) announced by the President in March. The reconnaissance aircraft, however, is substantially heavier and has a longer range.

Primary mission for the SR-71 is to provide post-attack reconnaissance over enemy territory in order to direct follow-up ICBM attacks on targets not destroyed in the initial attack. Also, the aircraft can be used to pinpoint for ICBM attack targets whose location was not precisely known prior to the outbreak of war.

In concept, this approach is closer to the Army's philosophy of using light aircraft, such as the L-19, to direct artillery fire than it is to the Air Force's doctrine of an aircraft which combines reconnaissance and strike capabilities.

● **Bombers & dinosaurs**—President Johnson's announcement of the SR-71 had both political and military implications. Politically, it deflated Republican charges that the Administration was jeopardizing the security of the country in the 1970's by not undertaking any new weapons system. Militarily, the development signals the intention of the Administration to continue reliance on ballistic missiles as strategic delivery systems. In no small way, it also complicates Air Force justification for an advanced manned strategic aircraft. It has been the contention of Defense officials that such manned bombing missions as may be required in the future can be carried out effectively by the F-111 (TFX) aircraft.

Development of the SR-71 began, the President said, in February, 1963. The first aircraft in the billion-dollar program will enter flight-testing in early 1965, Johnson announced, and deployment to the Strategic Air Command will begin shortly thereafter.

Significantly, development of the aircraft was undertaken at a time when the House Armed Services Committee was attempting to force the Administration to use funds voted for the RS-70 specifically and exclusively for that purpose. Committee Chairman Carl Vinson (D-Ga.) led that fight—even going so far as to write specific language into the authorization bill requiring funds to be spent on the RS-70. Only after "a walk in the rose garden" with President Kennedy, where he was presumably told of the SR-71, did he relent regarding the RS-70.

The SR-71, the President made clear, grew out of emphasis placed on the strategic reconnaissance mission by the Joint Chiefs of Staff in reviewing the RS-70. The new aircraft, it is said, will accommodate the multiple reconnaissance sensors needed by the Strategic Air Command to accomplish its strategic reconnaissance mission in a military environment.

● **Cost/Effectiveness**—Earlier in the week, Lockheed's C. L. "Kelly" Johnson told a press conference that he could foresee a need for a future strategic system but that the questions which must be answered are: "How much does the stuff cost per kiloton delivered? What do you do with bombers in the future if you have them?"

Even in the event that a missile misses its assigned target, he noted, it may not be the best answer to have a bomber waiting to check the target and then to deliver its own cargo of bombs or missiles. The solution, he said, may be an entirely different type of airplane, one that merely observes ICBM results and signals back to missile bases or to *Polaris* submarines for a second mop-up strike. He noted that the time required for even a second strike from U.S. bases is minimal. ■

Brown Blames LASV Demise on Congress

DIRECTOR of Defense Research & Engineering Dr. Harold Brown has put the onus for the death of the *Low-Altitude Supersonic Vehicle (LASV)*/Pluto program right back on Congress itself.

Testifying last week at closed-door two-day hearings held by a subcommittee of the Joint Atomic Energy Committee, Brown declared that the House Appropriations Committee in effect killed the program in mid-June, when it slashed $5.5 million from AEC funds designated for Tory II-C, the flight-configuration reactor which was successfully ground-fired in May.

This, Brown asserted, left the Dept. of Defense with two alternatives: to press for an expensive flight-test program or to cancel *LASV*/Pluto. Since there was only a remote possibility that an operational system would ever be deployed, he added, Pentagon officials regretfully decided on cancellation.

He described the project itself as "a model technological program."

Brown did not discuss what might have been a third alternative: to go before the Senate Appropriations Committee and ask that the fund cut be restored.

Rep. Melvin Price (D-Ill.), chairman of the investigating subcommittee, told MISSILES AND ROCKETS earlier that the hearing was being held "to get on record the specific reasons for cancelling the program, then seeing what should have been done."

SR-71 secrecy rapped . . .

Senate Committee Okays $46.8 Billion for Defense

Appropriations bill down $1.5 billion from FY 1964; members forecast bigger procurement funding next year

SECRECY FROM CONGRESS on the part of the Administration in the handling of the SR-71 aircraft has been criticized by a member of the Defense Appropriations Subcommittee. Only two top members apparently knew of the project's existence.

Sen. Gordon L. Allott (R-Colo.) said during debate on the $46.8-billion Defense Appropriations Bill that this secrecy placed the other members of the committee in a "very, very embarrassing and inconsistent position . . . that we have surveyed this budget . . . attended all the hearings, we have questioned and cross-examined all the witnesses and that we are satisfied in our own minds that we have as tight a budget as we can get, only to find out that $1 billion has been hidden for the development of something which has never been mentioned or named."

Sen. Leverett Saltonstall (R-Mass.) and Sen. Richard B. Russell (D-Ga.) were the enlightened members. Saltonstall said he deplored the necessity for such secrecy, but likened the situation to the Manhattan Project.

● **Procurement rise**—A substantial increase in procurement next year was forecast by Allott. The same feeling was voiced by Sen. Saltonstall, who said, "It is my earnest hope that this will not prove to be a one-year economy. I am aware that the services feel they cannot continue at this lower level of procurement."

● **Senate action**—The bill sent to the Senate by the Appropriations Committee was one of the four largest in peace-time years, although it is $1.5 billion less than the Fiscal Year 1964 bill.

While DOD asked for $271 million restoration of the money cut in the House, the final bill amounted to only about $16 million more than the House version. In individual actions, however, the Senate committee restored $106 million, but made $90 million in new cuts.

An amendment to cut the bill by 4%, or $1.8 billion, offered by Sen. George S. McGovern (D-S.D.) was defeated 78-5.

● **Comsat**—Both houses cut the communications satellite program by $22 million. In making this recommendation, the Senate group pointed out that only $38.5 million has thus far been obligated by DOD of the approximately $99 million available to it from Fiscal Year 1964.

Congress also reduced by $50 million the Secretary of Defense's emergency fund on the basis that "these monies are usually spent in the last 45-60 days for projects which could use more money but are not real breakthroughs." This fund had provided $150 million in previous years to finance research on "breakthroughs" which might arise after the fiscal year had begun.

● **Air Force procurement**—A total of $1.730 billion was approved for missile procurement, a figure identical to the budget request and that passed by the House. The Senate report also said that an additional $164.6 million will be available to DOD for missile procurement.

● **Air Force RDT&E**—The Senate deleted an additional $6 million from the House appropriation, an unusual occurrence since the Senate usually is more generous than the House. This brings the total appropriation figure to $3.1 billion, $93 million under the request. This $6 million encompasses the *Low Altitude Supersonic Vehicle (LASV)*, for which DOD recently announced it had no military requirement. The *LASV* would have been propelled by the Pluto nuclear ramjet engine.

Funds still remain in the budget for the chemically propelled version of the low-altitude missile, however.

The on-again, off-again *Mobile Medium Range Ballistic Missile* program was given the full authorization figure of $40 million, with no restriction that it be confined to use only on guidance.

● **Army procurement**—The Senate version of the bill provides for $6.2 million more than that approved by the House, bringing the Senate version to $1,656,396,000. The additional amount, the Senate committee said, was to bring the cut in the multi-system test equipment (MTE) from $29.7 million, to only $23.5 million.

Reduction of $19 million in the *Redeye* missile program, which Deputy Director of Defense Cyrus Vance asked the committee to restore, was upheld by the Senate committee. In doing so, the group indicated that *Redeye* has not proved itself an effective weapon for front-line troops, and that it will have to do better before it is allowed to go into procurement. RDT&E funds were allowed for the missile, however.

Other cuts agreed upon by both House and Senate include $12.5 million for electronics equipment, $56.6 million based upon a decrease in requirements, and $15 million for mobile air defense weapons and ammunition.

● **Army RDT&E**—The Senate concurred with House reductions, which allow a total of $1,340,045,000 for Army RDT&E. The only reductions made from the authorized amount are $5 million in a classified project which the Armed Services committees refused to authorize in the military construction authorization bill.

● **Navy procurement**—A total of $2,496,358,000 for aircraft, missiles and support equipment for the Navy and Marine Corps was approved by both houses. Reductions of $18.6 million from the budget request apply to the F-4 Phantom aircraft and electronics equipment. *Redeye* procurement funds asked for the Marine Corps were again refused.

● **Navy RDT&E**—The Senate restored $5 million to the House bill, bringing the total to $1,374,560,000. A total of $2.5 million was restored to a $144.2-million fund for research, and $500,000 of a $1-million reduction made in a request for $16.1 million for the advanced surface-to-air missile.

● **Defense agencies**—The Senate concurred with the House in allowing $498,715,000 for the various agencies in DOD, including Defense Communications Agency, Advanced Research Projects Agency, Defense Supply Agency, and "certain classified projects."

The total bill approved by the Senate committee now reaches $46.8 billion, $696.6 million under the budget request, and $1.449 billion under the FY 1964 sum. Total RDT&E provided in the Senate bill is $6.476 billion, $51 million less than that approved by the House. Total procurement funds are $13.453 billion, $16.9 million more than in the House version. ■

Officials Optimistic About Ranger VII Returning First U. S. Moon Pictures

Successful mid-flight correction put craft on course expected to bring it down near edge of Sea of Cloud

THE *RANGER VII* spacecraft appeared headed last week toward the first successful U.S. picture-taking mission of the Moon's surface.

Its chances of success were bright. Its TV camera system was reported to be in working order, and only an unforeseen mishap seemed to threaten the transmission of the lunar photos back to Earth. A successful mid-course maneuver July 29 sent the 806-lb. spacecraft hurtling right on target toward one of the planned landing sites.

Impact was assured in an area 11 degrees north to 21 degrees south of the Moon's equator. The area is called the Bonpland T. It is in the southwest coordinate of the Moon as viewed from Earth and near the edge of the Sea of Cloud.

Impact time was set at about 8:25 a.m. EST, July 31.

● **JPL optimistic**—Jet Propulsion Laboratory officials flatly predicted the spacecraft would send back to Earth the first closcup U.S. photos of the surface.

"The TV cameras are in excellent working order and are ready to be turned on at any time," Dr. William Pickering, JPL's director, said. If so, it would mark the first full success after 12 straight failures in the U.S. unmanned lunar exploration program.

Ranger VII was to make the 228,000-mi. trip in 67 hrs. and 25 minutes. The speed and attitude of the spacecraft was so nominal as it approached the end of its mission that JPL officials predicted that no terminal maneuver to aim the cameras or change their viewing angle would be required.

If the pictures were received in good condition, they were due to be available for public release by Aug. 2.

Launch of *Ranger VII* July 28 was completely successful after a ground support problem forced a one-day delay in the Cape Kennedy firing.

● **Launch phase**—The launch followed a perfect 6½-hr. countdown and came only six seconds after the opening of the launch window at 12:57 p.m. EST.

All booster systems performed perfectly. The flight marked the 17th straight successful mission for the *Atlas* as a space booster.

Thirty minutes after the liftoff, the *Agena* upper stage and the *Ranger* spacecraft were coasting in a 115-mi. parking orbit when the *Agena* was fired for the second time, sending the spacecraft to the 24,480-mph velocity required for injection into the lunar trajectory. Shortly after, *Agena* separation was confirmed.

The next critical maneuver occurred early July 29 when the mid-course guidance correction was made. It took place when the spacecraft was 99,280 mi. from Earth and 144,110 mi. from the Moon. The maneuver extended the flight of the spacecraft by 54 minutes.

It began at 5 a.m. EST. At 5:27:09, the mid-course motor was fired with a total burning time of 50 seconds.

This switched the landing site some 2,000 mi. The *Ranger* had been heading toward an impact on the back side of the Moon, but would now land as planned.

● **Photo sequence**—The sequence leading up to the actual picture taking was programmed to begin at impact minus approximately 15 minutes. The CC&S was to send a command to turn on the television system to allow it to warm up. At that time, the spacecraft was to be about 1,100 mi. from the Moon and its velocity increased to about 4,400 mph due to lunar gravity.

About a minute later, the camera sequencers were to turn the televison system on to full power and the cameras were scheduled to start taking pictures and transmitting them to Earth by the two 60-watt transmitters.

From that point until *Ranger* hit the Moon, the two wide-angle F cameras, F chain, had the capability of taking pictures at intervals of 2.56 seconds.

The four narrow-angle cameras, P chain, could take pictures at intervals of 0.2 second. Depending upon the altitude of the turn-on, the first pictures taken by the cameras could show areas of the lunar surface that are 180,000 and 19,000 sq. mi. for the wide-angle cameras and 12,500 and 1,200 sq. mi. for the narrow-angle cameras.

The first pictures should have a resolution comparable to those taken by Earth-based telescopes. They will be important, however, in identifying the general area that is being photographed.

The picture with the best resolution was to be taken a few seconds prior to lunar impact. In the case of the F cameras, a picture taken at impact minus 2.5 seconds with the 25-mm lens would record an area of approximately 3.5 sq. mi. The 75-mm lens would cover an area of about 0.38 sq. mi. At that time, *Ranger* would have been only four miles from impact.

The P camera was to take the last complete picture at 0.2 sec. before impact when the spacecraft was about 1,750 ft. from the Moon. The 25-mm lens would provide a picture of 37,500 sq. ft. and the 75-mm lens a picture covering 4,350 sq. ft.

The pictures were slated to be received by two 85-ft.-dia. antennas at the Goldstone, Calif., tracking station. NASA has selected five scientists to evaluate the pictures: Dr. Gerald P. Kuiper, University of Arizona; Dr. Harold Urey, University of California; Dr. Eugene Shoemaker, U.S. Geological Survey; Ewen A. Whitaker, University of Arizona; and Raymon L. Heacock of JPL. ■

To cost $200 million . . .

Global Comsat Pact Assures U. S. Up To 61% of Contract Money

Member nations agree that ComSat Corp. should manage system, cost of which will be shared according to usage

MEMBER NATIONS of a Global Commercial Communications Satellite System have approved an agreement which provides for at least 50% and up to 61% of its total estimated cost of $200 million to be spent in the U.S.

The pact provides that whenever "proposals are determined to be comparable in terms of quality and price," contracts should be distributed to the various member nations in approximate proportion to the member nation's share of the cost of the system.

The U.S. share is currently 61%. According to an earlier pact, it cannot drop lower than 50.6%.

Details of the system, which will be managed by the U.S. Communications Satellite Corp., were contained in two agreements approved by member nations last week.

One pact is intergovernmental in character and includes the organizational principles established for the international system. The other is a special agreement that deals with the commercial, financial and technical operations of the System.

Under their terms, member nations have agreed to pay their proportionate share of the system's estimated total cost of $200 million.

Each nation's share of the $200 million will be directly proportionate to the nation's assigned quota, which is based on its estimated usage of the system.

If the cost rises above that level, the nations will not be required to make financial contributions. If the cost rises above $300 million, a special conference will be called to decide how the additional cost will be apportioned.

• **Membership**—There are 19 prospective member nations of the system. Fourteen, including the U.S., have already initialed the agreements. Actual official signing of the pacts will be delayed until Aug. 19, at which time they will be open for signing for six months. Additional members may sign later if the countries are members of the International Telecommunications Union.

The pacts provide for two governing groups. One, the Communications Satellite Corp.—as the representative of the United States—will act as manager in the design, development, construction, establishment, operation and maintenance of the space portion of the system.

An Interim Communications Satellite Committee has also been established. This committee, however, will be dominated by ComSat Corp. It will be composed of all member nations having a quota of more than 1.5%. The vote of each member of the committee will be equal to its quota. Because ComSat has been assured of at least 50.6% of the quota, it will control the majority of the votes on the committee.

The Interim Committee will operate until Jan. 1, 1969. It will then recommend whether to continue the interim operation or whether a permanent international group will be established to run the system.

• **Contracting**—The agreements also detailed procurement policies for the system, which it said should attempt wherever possible to place contracts in member nations in direct proportion to their quota.

All contracts placed by ComSat—in its role as manager of the system—or any of the other signatories, shall be made on an open request for bids. For contracts over $125,000, requests for quotations or invitations to tender shall be in accordance with conditions the committee establishes.

ComSat Corp. is required to consult the interim committee before issuing requests for space equipment to cost over $500,000. The corporation will make a recommendation and the committee will then make the final approval.

• **Ground stations**—The committee will also have jurisdiction over ground stations using the satellite system. Whether a ground station will be authorized will depend upon technical characteristics of the station, technical limitations on the multiple access to satellites resulting from the existing state of the art, effect of geographical distribution of Earth stations on the efficiency of the service to be provided by the system, recommended standards of the International Telephone and Telegraph consultative committee and the International Radio consultative committee of the ITU, and other standards set up by the committee.

Applicants for ground stations will also be required to make "equitable and non-discriminatory arrangement" for the stations use by all signatories to the agreements.

As manager of the system, ComSat will be responsible for the preparation and submission of annual budgets; recommendations on the types of satellites to be used; planning, conducting and arranging for a cooperate in studies, design and development of improvements; and for operation of the system.

List of prospective signatories to the special agreement and their quotas: Australia—2.75; Austria—0.2; Belgium—1.1; Canada—3.75; Denmark—0.4; France—6.1; Germany—6.1; Ireland—0.35; Italy—2.2; Japan—2.0; Netherlands—1.0; Norway—0.4; Portugal—0.4; Spain—1.1; Sweden—0.7; Switzerland—2.0; United Kingdom—8.4; United States—61.0; Vatican City—0.05.

In another ComSat development, the corporation announced that its board of directors has elected John A. Johnson, who has been serving as director of international arrangements, as vice president-international.

Johnson has been director of international arrangements of the corporation since Dec. 9, 1963. In this capacity, he has participated in the drafting of plans for the development of a global commercial communications satellite system and in various discussions and negotiations with entities of other countries.

From October, 1958, until he joined the corporation, Johnson was general counsel for NASA. Previously he had served for six years as general counsel for the Air Force. ■

Nimbus Launch Is Two Years Late

Program cost jumps at least $10 million, refinements include ability of cameras to point at Earth at all times

THE SPACE AGENCY expects to launch a *Nimbus* weather satellite this month—more than two years behind schedule and with a total program cost of $140 million.

For that price tag, the U.S. is getting *Nimbus A*, a backup spacecraft, and the *Nimbus B* spacecraft, the first NASA satellite to use nuclear power.

All three, however, are simply R&D vehicles. The Weather Bureau—which makes the final decision in such matters —has already turned thumbs down on space agency plans to use *Nimbus* as part of a National Meteorological Satellite System. It has instead selected the "cartwheel configuration" *Tiros* satellite for use in the NMSS.

The original launch date for *Nimbus* was set by NASA as the second quarter of 1962. Rescheduled for launch many times, it continued to slip month after month. Officials now hope to get it off the ground around Aug. 11.

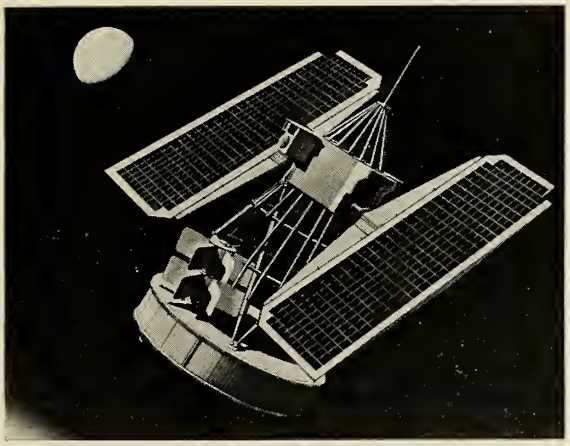
● **Slippage causes**—A NASA official told MISSILES AND ROCKETS that a half year in the schedule was lost because of refinements in design, another year was lost because of problems in the development of subsystems, and another six months by integration problems.

Original estimate of the program's cost was $130 million. NASA now says it will probably be at least $140 million because a tentative decision has been made to launch the backup *Nimbus A* spacecraft even if next month's launch is completely successful.

The *Nimbus* does embody major steps forward beyond the *Tiros* series, including the ability to point its cameras at Earth at all times, and the capability of providing complete global cloud coverage every day.

Other major steps forward are the use of specially developed high resolution infrared radiometers, which will be used to take experimental night pictures of clouds, and direct local readout of the pictures with the use of relatively simple, inexpensive ground stations. The latter, however, is already being tested in *Tiros VIII*.

● **Satellite details**—The *Nimbus A* satellite—scheduled for launch Aug. 11, weighs about 750 lbs., twice the weight of the *Tiros* satellites. *Nimbus* is 10 ft. high and five feet across the sensory ring at its base.



DRAWING of Nimbus B shows two SNAP-19 nuclear generators stacked on satellite's forward rim. Each is designed to deliver 30 watts of direct electrical current.

The sensory system includes three vidicon cameras, the automatic picture transmission system (APT) and the high-resolution infrared radiometers, (HRIR) for providing night cloud coverage. The second *Nimbus* will be available for launch in the last quarter of this year.

Nimbus B will be launched sometime in Fiscal '66. It will use a redundant system of advanced vidicon cameras, a redundant automatic picture transmission system, a single high-resolution infrared system and an advanced medium resolution infrared radiometer. Because of the heavier equipment, *Nimbus* will be launched by a *Thrust-Augmented-Thor/Agena* booster.

It will be powered by two nuclear generators being developed by the Martin Co.'s Nuclear Div. The firm is building six of the generators under a $1.5 million contract with the Atomic Energy Commission. Designated *SNAP-19*, each of the generators will be fueled with plutonium 238, and is designed to deliver 30 watts of direct electrical current.

● **Nuclear power source**—The nuclear systems have no moving parts. Power is provided by the spontaneous decay of the isotope fuel, which generates heat inside the tightly sealed container. The heat is converted directly into electrical energy by an assembly of thermocouples. The generators will be 11 in. high and 22 in. dia., including fins. Each of the generators will have a design lifetime of five years.

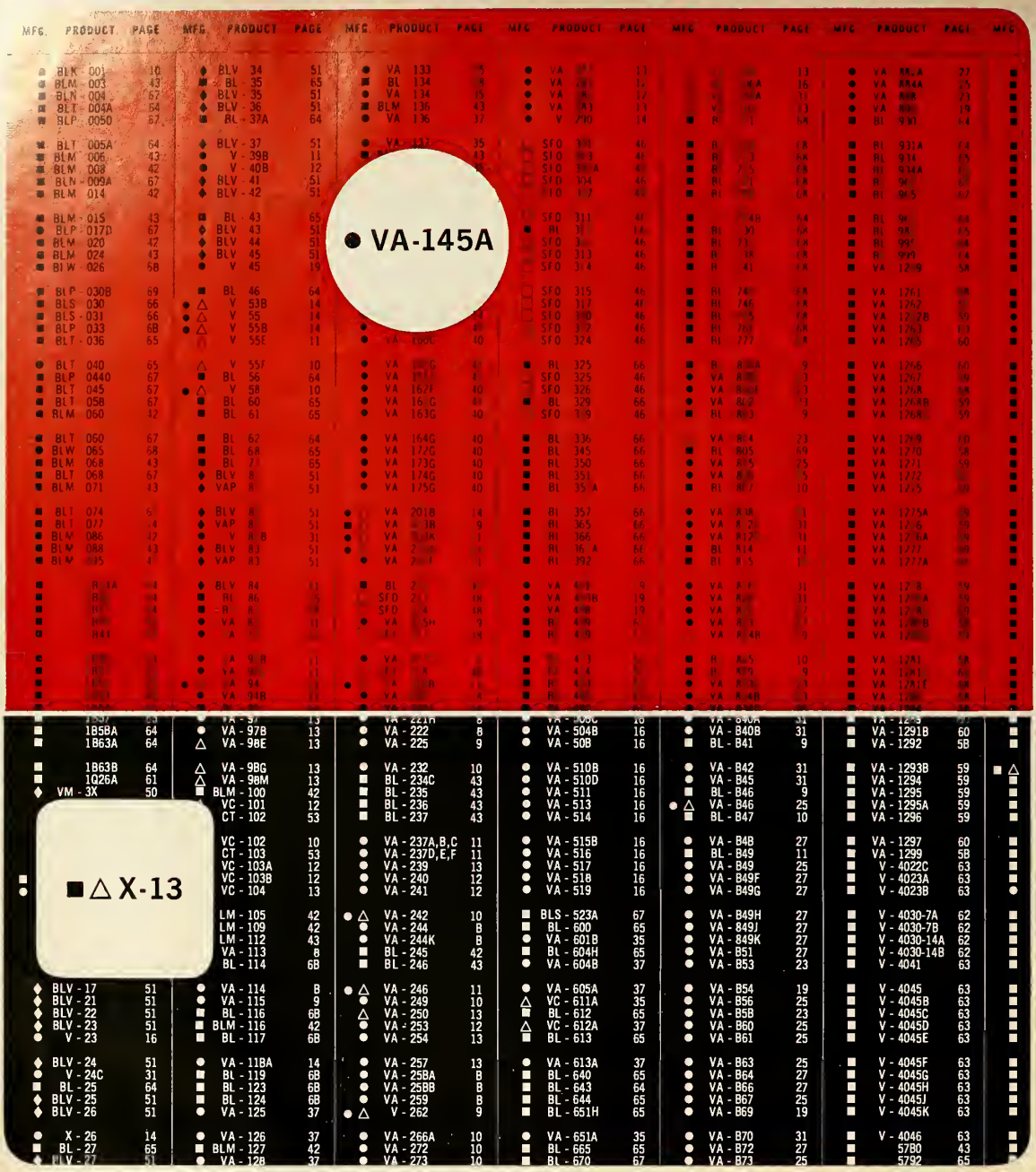
Plans call for delivery of the first units in early 1965.

The Martin Co. reports that the units will not menace the Earth's atmosphere.

They are expected to remain in orbit for more than 700 years. During this time, the radioactive fuel, the firm maintains, will undergo almost complete decay.

Upon completion of their expected orbital life or in the event of premature re-entry into the Earth's atmosphere, the generators will burn up into particles about one millionth of an inch in diameter from the heat of re-entry.

These minute particles will be widely dispersed in the Earth's atmosphere, and even though complete radioactive decay may not take place, the particles dispersed will increase the activity in the atmosphere by an amount too small to present a risk to the world's population, the firm said. ■



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Technical Countdown

ELECTRONICS

Space Station Control Simulator Studied

NASA's Langley Research Center has awarded the Sperry Gyroscope Co. a four-month, $50,000 study and preliminary design contract for a manned space vehicle (primarily space station) control-system flight-test-simulator. Sperry engineers, attempting to define the most effective general purpose test system, are now reviewing all possible control system configurations that have been proposed for use with space station concepts ranging in size from *Apollo* types to the large orbiting platforms under study at Houston. Basically, the test system, if developed and installed at Langley, will couple a three-axis motion simulator with digital and analog computers. No hardware will be built under the current Langley contract.

Gas-Laser Output and Efficiency Gains Claimed

Bell Telephone Lab scientists report they have achieved the highest continuous power thus far obtained from gas lasers. Outputs of 1 watt, which BTL claims is a tenfold increase in output power, have been measured using a helium-neon laser operating at 6,328 Å. Input power is 500 watts dc, which gives the laser an efficiency of 0.2%. The laser includes a 5.5-meter-long discharge tube, 1 cm. in diameter, and new low-loss mirrors mounted outside the tube.

Cook to Build DF's for Manned Missions

Direction-finding equipment for use by the Air Force in its tracking/recovery support of NASA's *Gemini* and *Apollo* spacecraft will be developed by Cook Electric Co. The firm's Tech-Center Div. said the equipment, which will be carried aboard HC-130H aircraft, will record space vehicle bearings automatically at 2-sec. intervals. Solid-state and greatly miniaturized, the system will locate both HF and LF signals—either from beacons or voice communications during vehicle descent.

New Encoders Score in Numbers Game

Three newly developed analog-to-digital converters, under test by Norden Division of United Aircraft Corp. for the past three months, have each passed the 18-million-revolution mark. The size 18 encoders, Norden engineers claim, are still performing noise-free and counting correctly. As a result of these and other long-term life tests performed by the division, Norden soon will offer the units commercially with a guaranteed minimum operating life of 7.5 million revolutions. The encoders will be available as a family of self-selecting, brush, binary encoders including 7-, 13-, and 19-digit versions.

New Recorder Testers Delivered

Expanded test equipment that will help determine standards for future high-performance electron-beam recording media has been delivered by Ampex Corp., Redwood City, Calif., to the Air Force Avionics Laboratory at Wright-Patterson AFB, Ohio. A testing system supplied to the laboratory two years ago was used primarily for evaluation of thermoplastic media. The modified equipment, however, permits evaluation of a broader range of media, including silver-halide film with which Ampex recently demonstrated information readout at bandwidths of 60 mc.

MATERIALS

Nuclear-Satellite Fuel Loader Planned

A remotely-operated device for loading a radioisotope thermoelectric power supply into a space satellite at the launch site will be developed by United Shoe Machinery Corp. under contract to General Electric's Missile and Space Division. The system will be designed to handle such loads with the *Atlas-Agena* launch vehicle system. Initial phases of the contract are funded in excess of $100,000.

Compressor May Simplify Gas Lubrication

A free-piston, gas-lubricated compressor designed for use in a family of gas-lubricated inertial-guidance systems is under development by ITT Federal Laboratories for the Air Force. The only moving part, ITT said, is the free piston, which rotates and oscillates simultaneously to introduce, compress and exhaust the operating gas through a pattern of ducts and ports. Valves, said the company, are not required in the cycle.

PROPULSION

Lighter Weight TOW Launcher Sought

TOW launch tubes soon may shift to reinforced plastic. A small number of the tubes will be built by Haveg Reinhold, Inc., for Hughes Aircraft Co., developer of the anti-tank missile. The present goal, Haveg said, is to develop an experimental tube providing optimum strength-to-weight ratio. The system now weights just under 160 lbs. and is carried broken down in four parts by its infantry users.

SPACE MEDICINE

Closed Water System in Development

A closed ecological life-support system, being built under NASA contract by General Dynamics/Astronautics, would enable an initial supply of 29 gallons of water to serve the needs of a four-man space station crew for a year. The water regeneration equipment, one of many subsystems in the complete life-support system, would recover and purify water from several sources, including urine and excess moisture in the cabin air. The system, when completed, will undergo both manned and unmanned tests in a mockup space station to be built at GD/A. The program is under the direction of NASA's Office of Advanced Research and Technology.

Zero-G Brain Tests Proposed

Douglas Missile and Space Systems Div. and scientists at the University of California at Los Angeles have proposed a new satellite system to NASA, which would involve orbiting a chimpanzee with electrodes implanted in his brain to study the effects of weightlessness on the human brain. The project, which the team suggests be named HOPE for Highly-instrumented Orbiting Primate Experiment, would consist of 10 space chimps, which would be trained for various phychomotor tests to be performed in orbit.



BULLPUP B in recent firing from Navy/Douglas A-4 Skyhawk at Pt. Mugu, Calif.

management

Single Source Procurement Yields Further Bullpup Cost Savings

by Michael Getler

THE UNIT PRICE of *Bullpup* air-to-surface missiles has dropped to about 20% of its initial cost in 1958.

This notable accomplishment is the outgrowth of a continuing round of prime-contractor reductions in production costs, the introduction in 1961 of a second industry source for the missile, and the subsequent competitive bidding for the multi-year sole-source buy awarded in June (M/R, June 29, p. 9).

The competition for procurements in fiscal years 1964 and '65 was won by Maxson Electronics Corp., which thus replaced Martin Co.,'s Orlando (Fla.) Div.—the original *Bullpup* prime and its largest supplier—as the sole source.

Martin's substantial cost reduction efforts (M/R, Mar. 12, 1962, p. 16), the introduction of Maxson as a second source and the competitive reductions have saved the Navy and Air Force more than $40 million, DOD estimates.

These savings have been effected primarily in the guidance and control portions of the missile, which comprise about two-thirds of *Bullpup's* cost and constitute the bulk of the Martin/Maxson production effort. The warhead and the propulsion unit are provided under separate contracts. Observers point out the 20%-of-original-cost ratio is based on the cost of the entire missile; industry effort has reduced the G&C cost to about 10% of the initial price.

● **Evolution**—The pricing history of *Bullpup,* pieced together from a number of sources, looks something like this:

The initial unit cost of the non-warhead or motor portions in 1958 is believed to have been in excess of $10,000. Cost reductions by Martin knocked this down to about $5,500 during the 1959 contract period, and further reduced it to about $5,000 in 1960.

In 1961, before the Navy announced its intention to attempt to qualify a second source, the price apparently was further lowered to about $4,700. That same year, after the announcement but before Maxson qualified, the price is believed to have tumbled another $600. After the qualification of Maxson, in May 1962, the price was down to $3,100 or less. Subsequent competitive reductions lowered the cost to where it is now—some 10% of the original.

Although the Navy's Bureau of Weapons, which buys *Bullpups* for both the Navy and Air Force to achieve additional price concessions, has now reversed itself and gone back to a sole-source procurement, an effort probably will be made to retain Martin's interest in the program for possible future buys. This presumably would spur Maxson to further cost-cutting.

● **Several firsts**—The *Bullpup* development effort is unique on several counts.

The missile is one of the first to be successfully second-sourced; in the air-to-surface category *the* first. In the late

50's, the Navy had successfully second-sourced, between Philco and General Electric, the G&C for the air-to-air *Sidewinder*, also with favorable financial results.

For the time being at least, Maxson joins an even rarer grouping—one-time second-source producers who have gone on to become sole suppliers.

The company, with total corporate sales of $13.7 million in FY '63 and $9.3 million in the first half of its 1964 fiscal year, probably can also lay claim to being the smallest corporation to hold a sole source on a major missile.

The June contract, announced as a $23.5-million multi-year award, is also the first of its kind used by BuWeps for a missile system, though the contract conditions are slightly different from what the name implies. The contract includes a firm buy for FY '64 under an $11,760,552 fixed-price award and provision for incremental funding of the balance by BuWeps prior to Jan. 31, 1965. BuWeps at the time of the award was not legally able to commit the entire amount since it did not yet have title to FY '65 funds. There is a clause which provides an out for BuWeps prior to the incremental funding with a penalty which DOD sources say "is not too severe."

Navy sources told MISSILES AND ROCKETS that they consider the contract and the quantities a firm two-year award, not likely to be opened to renewed competitive bidding for the second half. The Air Force, however, still has some uncertainties regarding the types and quanties for its FY '65 buy.

• **Contract history**—Maxson's first contract for *Bullpup* came in March, 1961, when it was selected from a field of 35 firms to establish a second production source. The fixed-price $2.3-million contract was primarily for tooling and a limited number of missiles.

Missiles produced under this contract were successfully qualified by May, 1962, and in August of that year the Navy exercised an option in the original contract and gave the firm an additional $2.7 million for a larger quantity, though still a small fraction of the overall program. In February, 1963, the firm came up with an $8.9-million incentive award, reportedly worth about a third of the FY '63 buy.

In January of this year, according to industry sources, the Pentagon made it known that because it had two fully qualified volume suppliers—and its requirement, at least for the A-version of the missile, was somewhat reduced due to growing stockpiles—it would attempt to place a multi-year buy with a single contractor.

Bids were submitted in May. Insiders say the firms involved actually submitted a half-dozen separate bids involving individual year quotes, multi-year quotes, and separate estimates on both versions of the missile. It is further reported that Maxson was low bidder in each category, and that this made the multi-year sole-source buy possible, placing Maxson in the role of a small but successful campaigner against a company with a reputation for "hard-nosed pricing."



MACHINE-FINISHED nose and center sections stacked in production area.

Maxson will build both A- and B-versions of the *Bullpup*, the former believed to be solely for AF inventories. The B has already been produced by Martin, but, the Maxson buy reportedly will involve the largest B production run to date.

• **The weapon**—There are three basic versions of *Bullpup*, a supersonic, radio-command/visual guidance missile. The A-version (AGM-12B) weighs about 570 lbs; is 11 ft. long, about 1 ft. dia., and delivers a 250-lb conventional warhead to a maximum range reported to be about 6 mi.

The newer *Bullpup* B (AGM-12C) is longer and much heavier than the A, using a new prepackaged liquid-propellant motor made by the Reaction Motors Div. of Thiokol Chemical Corp. that reportedly extends the range to about 9 mi. The B version can carry a 1,000-lb. warhead. Some A missiles now have the new motor, while others use an earlier solid-propellant system.

A nuclear version of the missile (AGM-12D), similar in configuration to *Bullpup* A, has been developed solely for Air Force use. Details are classified.

Lowering the cost of the missile apparently has also caused BuWeps to at least reconsider or possibly drop its plans for additional buys of a trainer version of *Bullpup*.

Though the current BuWeps buy extends through FY '65, many service and DOD sources believe *Bullpup* may be in budget requests for a number of years to come.

The missile has been in service since 1961. It is designed for use with all U.S. tactical aircraft, including the newer McDonnell F-4C and Grumman A-6. It is also believed to be already slated for the AF version of the F-111 (TFX). In addition, the missile may find a rack aboard the Navy's new A-7 VAL general-purpose aircraft now under development.

Observers point out that there is no other air-to-surface system which can replace *Bullpup* for the broad range of tactical missions, though the new *Walleye* glide bomb, now in engineering development by the Navy, is expected to show "a degree of replacement on certain type targets." *Walleye* does not have a propulsion system, yet its range is reportedly "comparable" to that of *Bullpup*. However, both systems have range limitations imposed by visual conditions and altitude.

• **DOD's approach**—The multi-year buy concept which DOD has now begun to implement is intended to produce additional price savings by avoiding annual "startup" costs and giving the winning producer an incentive to offer a lower price based on the efficiencies that can be achieved over a long production run. With this in mind, the con-

tractor can go to his subcontractors and offer the same incentives.

This procedure, in combination with competitive price reductions induced through second sourcing, has obviously been beneficial to the service user in the case of *Bullpup;* it raises some more far-reaching questions, however, of risk and profitability for the contractor left holding the missile.

DOD cost analysts estimate that by introducing a second source on *Bullpup,* they reduced, by an estimated one-third, the projected cost of the program carried out by a single contractor; they concede, of course, that it is hard to second-guess as to just how much a single prime could accomplish by value engineering and cost control throughout any one program.

This is not an indictment of Martin or any other prime but merely the result, as many backers of second-source methods point out, of the introduction of another manufacturer and the inevitability of forcing even further efficiencies on firms that have already done a creditable job.

• **Good gamble**—As one expert puts it "When you have a second source, you have people willing to underbid one another or even, in some cases, to take a loss." Insiders say Maxson may indeed have taken a loss in initially getting into the *Bullpup* program, but that the continuing competition between the two firms for subsequent awards, and associated audits, suggests that there was profitable business.

The "little more arm twisting" inherent in second-sourcing can force down a firm's profit margin, according to one spokesman, "and the program dollars will shrink; but by forcing him and his subs to be efficient, his profit rates may not have to change."

The danger in buying into a multi-year procurement is probably greater than that involved in getting into a program by simple low- or no-profit bidding. The temptation, an observer notes, is for a firm to "bank on buying in the first year in the hope of making a load on the second one." Experts say this is definitely a gamble with ordnance systems, where uncertainties of technology and requirements change rapidly. However, "you never *really* know if a firm has bought a contract until they perform," adds one Navy project officer.

While the Navy and DOD agree that second-sourcing has fared well with *Bullpup,* its applicability to other programs is said to be limited by weapons system complexity—more complex systems exact a higher toll from DOD. Both *Bullpup* and *Sidewinder* are regarded as relatively simple systems. Critics of the second-source approach for large systems argue mostly for choice of a single contractor on a multi-year contract, based on the initial competitive bids of several firms.

• **Bad side**—The *Bullpup* history is also unusual in that Martin, the missile developer and prime contractor, is now virtually removed from the production phase of *Bullpup* after six years as its major supplier, and four years as its only supplier. While there is no doubt that second-sourcing can lower the price of a weapon, it also raises the question of long-range profitability for a systems company which has invested heavily in R&D facilities to provide the capability to develop a new weapon.

The *Bullpup* turnabout, in the minds of some observers, poses serious questions of future increases in development cost charges by systems firms who know that they may well be challenged in the production lifetime of their system by smaller firms—those without the R&D facilities to bring forth a missile in the first place, but with good production skills applicable to the normally profitable production phases.

Nevertheless, *Bullpup,* which has now become a single-source multi-year program, has been heavily documented within DOD. A summary of its cost-reduction efforts has recently been circulated to service officers where decisions as to single- or multiple-source selections on weapons projects are made. DOD sources stress that they are not trying to peddle second-sourcing where it may not belong; they say they are only providing documentation of a proven case, otherwise not readily available, which could be helpful to a project office.

Though Maxson was designated as a second-source prime early in the program, the firm never had the overall systems role which Martin provided. Martin, for example, also supplies the aircraft-mounted portions of the system and large-scale logistics support of *Bullpup* squadrons. The firm will no doubt be called upon to supply additional aircraft components when required. Only the missile is being bought currently.

Loss of *Bullpup* production, Martin says, does not affect its relationship with the NATO production consortium manufacturing *Bullpup* in Europe. NATO production is conducted under a licensing agreement with Martin, which also furnishes some parts and technical assistance.

While the three major *Bullpup* sections—nose cone, warhead, and propulsion—are interchangeable (as are the major systems), Maxson, as a second source, did have design cognizance over the missile it turned out and in many cases used different components from the Martin missile. The gyro, for example, used in the Maxson version is different from the Martin one; though the guidance system is interchangeable, the gyros are not.

• **Boost for Maxson**—The impact of *Bullpup* on a firm the size of Maxson is apparent. In FY '63, the missile accounted for 25% of corporate sales. In this fiscal year, which ends for the firm on Sept. 30, *Bullpup* is expected to account for 40-45% of corporate sales.

William Maxson, Jr., president of the corporation, pointed out to M/R that the relatively flexible management, very short communication lines, and direct management view of production found in a smaller firm were important factors in the firm's successful competition. "This," he said, "is not a criticism of Martin, but purely a factor of size." Discusing the overall cost reductions, he said that "no matter what a single firm has done in cost reduction, this becomes, in virtually every case, almost totally inadequate when competition is introduced."

Maxson estimated that the current unit cost of the missiles now being turned out by the firm is less than half of the original Maxson price.

In becoming a qualified second source, the firm was required to develop its own team of subcontractors. Maxson subcontracts about 70% of the work, keeping in-house the receiver guidance system, machining work on most of the internal components, final assembly, test and checkout.

• **Bullpup team**—Major subcontractors selected by Maxson to take part in the recent contract so far include: the Chandler Evans Corp. (valve assembly portion of the flight control package); Courter Products Div. of the Model Engineering and Manufacturing Co. (the single stabilization gyro); Walter Kidde & Co., Inc. (compressed air pressure tanks for control systems); and Bulova Watch Co. (crystal packs in the guidance section). Additional subcontractors will be named for the missile battery, aluminum sheeting and extrusions, wings, and nose cone. Maxson officials say there could be some shifting of subcontractors, including some members of the Martin team.

The Maxson Electronics Div., headquartered at Great River, L.I., N.Y., is the only one of Maxson Electronic Corp.'s five operating divisions which is involved with *Bullpup.* The division has two major facilities—one at Old Forge, Pa., where the major production work, assembly and checkout is done, and the other at Great River, where printed circuit board, receiver circuitry, and some machining is handled. Old Forge has about 75,000 sq. ft. and some 175 employees. The Great River plant, just two years old, has some 375 people and 225,000 sq. ft. Both facilities are expected to add employees to handle the additonal *Bullpup* volume. ■

Low-Pressure Potassium Vapor Powers Two-Stage Turbine at GE

by John F. Judge

NUCLEAR SPACE POWER turbogeneration technology has passed a major milestone with the operation of a two-stage turbine on potassium vapor at General Electric's Space Power and Propulsion Section, Cincinnati, Ohio.

The next move will be into endurance and performance testing. The GE section, which is managed by M. A. Zipkin and is part of the Re-entry Systems Dept. of the firm's Missile and Space Div., has always insisted that the turbine is the key to an operational nuclear space power generating system.

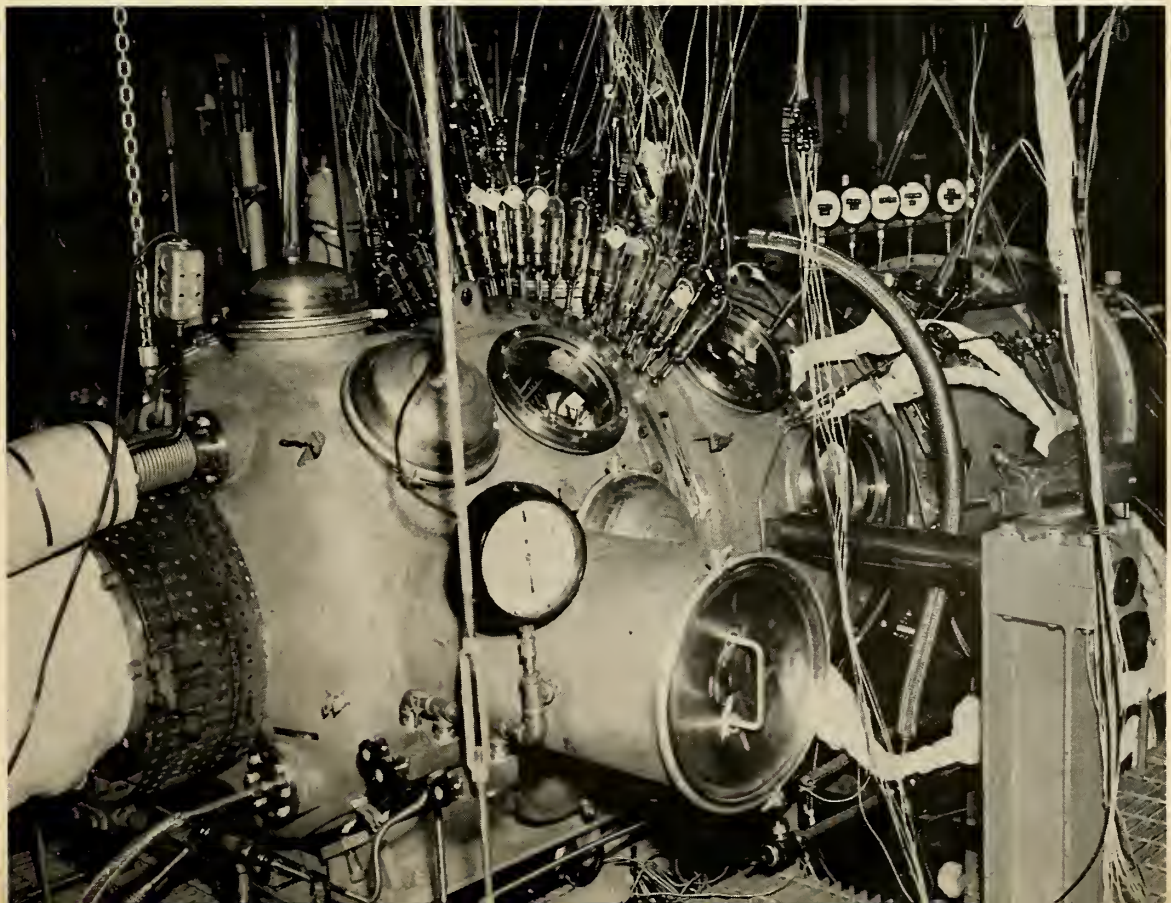
Liquid metals were originally chosen over steam because the properties of materials such as potassium are such that a 1,600° to 1,800°F potassium vapor pressure remains under 100 psi. Steam at equivalent temperatures would exert up to 3,000 psi pressure.

The GE turbine is part of a dynamic test facility (M/R, Feb. 17, p. 26) designed to investigate all the problems associated with high-temperature, liquid metal power systems. The turbine study is being funded by NASA's Lewis Research Center.

● **Operational sequence**—The boiler was ignited at 9:00 a.m. July 13. As the potassium heated in the facility, the turbine was preheated by the wrap-around heaters on the inlet line to approximately 1,150°F, and adequate oil flow was established to all bearings to keep them at proper operating temperatures.

All flows were established in the rear-end loading components, and adequate heating of the condenser and

METAL VAPOR two-stage turbine is enclosed in this glove box, which maintains an argon atmosphere around assembly during tests. Pressure line "de-misters" prevent potassium blockage. Equipment at right measures turbine output.



other facility components was established. The main scrubber system was turned on, as well as the induced draft blower used to draw cooling air through the condenser.

The argon reclamation system was turned on, and good steady flows were indicated through both the potassium side and oil side labyrinth seals into their respective sumps.

The turbine was started up with the auxiliary steam turbine and operated at about 10,000 rpm to establish the hydrodynamic seal. When potassium was admitted to the hydrodynamic seal, the turbine speed dropped about 500 rpm. Speed was then re-established at about 10,000 rpm by manual control.

● **Maintaining the seal**—After establishing the hydrodynamic seal, pumping down of the main loop began. As the pressure in the main loop continued to drop, it became necessary to increase the speed of the turbine to maintain the hydrodynamic seal against the increased pressure differential. Finally, the speed was set at 16,000 rpm and held steady as the potassium boiler temperature came up to operating conditons.

At 11:29 a.m., the first signs of potassium vapor from the boiler became evident as the turbine speed began to increase. Immediately, the steam pressure to auxiliary turbine was reduced and the potassium turbine was allowed to pick up the load. The steam pressure was reduced to about 20 psi and held there as load was applied to the water brake. About 10 gpm water was admitted to the brake, and load control was maintained by controlling inlet flow.

Ten minutes after initiation of potassium boiling, the turbine was completely self-sustaining and operated without assistance from the auxiliary steam turbine.

Turbine speed held reasonably steady while the temperature rose in the inlet vapor line and turbine as the boiler put out more and more vapor and placed greater and greater load on the turbine. The boiler temperature climbed to greater than 1,500°F while turbine vapor inlet temperature reached about 1,450°F.

Observations of the flow-out of the screw seal cavity showed that no potassium or oil had crossed the labyrinth seal. (This had been a problem in previous tests of the turbine.) The running was very smooth, with all bearing temperatures being exactly as GE designers had predicted. This was especially significant since the pivoted pad bearing was running at less than 200°F even though glowing hot turbine wheels were operating less than 2 in. away.

PRELIMINARY DATA ON FIRST RUN OF TWO-STAGE POTASSIUM TURBINE

DATA PT.	1	2	3	4
Speed (steady state) RPM	15,944	15,043	14,522	12,312
Temperature inlet °F	1232	1224	1431	1501
Pressure inlet—psia	6.50	5.86	18.14	24.91
Pressure outlet—psia	3.43	3.23	7.63	14.63
Total/static pressure ratio	1.764	1.811	2.377	1.703
Vapor quality— %	100.3	99.5	99	100.8
Trubine power output—bhp	58	52	107	76

(The turbine is designed to produce 250 hp at 19,200 rpm, 1600°F, 92% quality)

● **Potassium run smoother**—All ball bearings in the water brake, steam turbine, and main potassium turbine were running smoothly and well within temperature limits. Vibrations were very low as indicated by Sanborn tracings, and the g-loadings of the main potassium turbine were less than 1.5 g's throughout the entire operation. This compared to values of normal operation in excess of 3 g's exhibited in previous testing. The turbine seemed to run smoother when hot than when it was driven with the steam turbine turbine under cool conditions.

After 30 minutes of operation, there were several sharp decelerations followed by completely smooth recoveries of speed with no adverse effect on turbine operating conditions. GE engineers postulated that several things could have caused these speed excursions—slugs of liquid potassium coming from the boiler, sporadic overloading of the turbine by the water brake, which was operating at the low end of its braking capability.

The 8-in.-dia. valve in the vapor inlet line was partially closed to flash any incoming liquid to vapor. This appeared to have a positive effect as turbine speed smoothed. But after a period of time, several speed excursions were experienced.

Power was then increased to raise the load on the water brake. As the power level increased, it appeared to improve stability.

The system was shut down approximately four hours after inception of vapor flow into the turbine. The turbine was then motored until 5:00 a.m. the following morning to allow a complete cooling down of all parts before shutdown—preventing any warping of parts. The shutdown and conclusion of the test were normal and successful, indicating no malfunction of any of the equipment.

During the testing, a number of data points were taken providing some performance readings, instrumentation was checked out and some digital readings were obtained. The data provides only a start on that required to define the performance of the turbine.

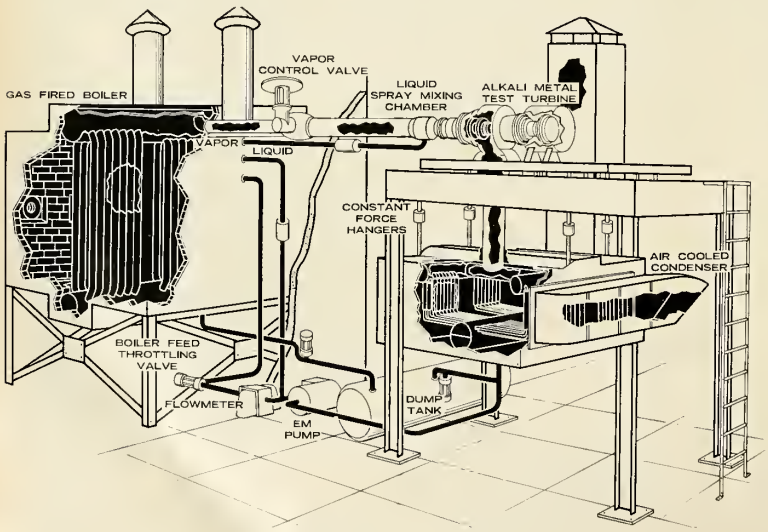
● **Test program details**—Endurance runs slated for the immediate future will initiate data production on both performance and the erosion of blade materials over long-time exposure to high-temperature potassium vapor.

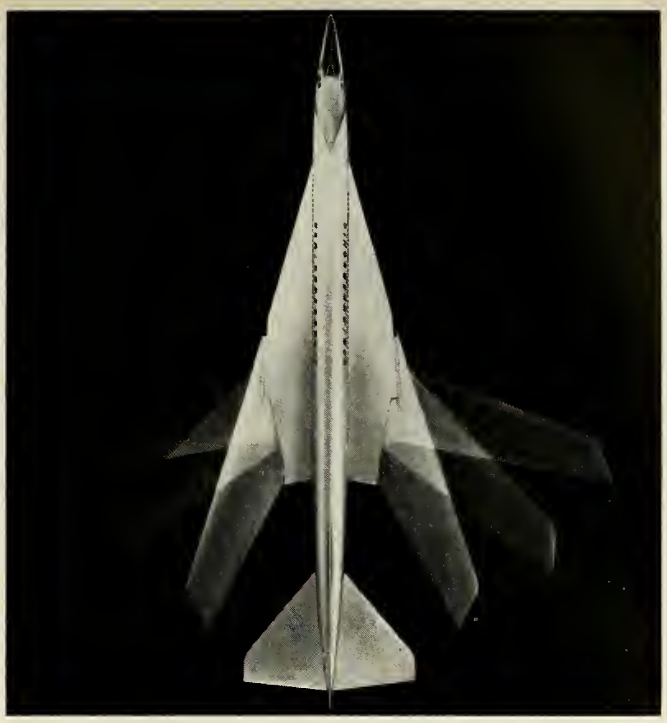
The turbine test program is divided into three phases. First, aerothermaldynamic characteristics of the turbine will be established in a series of performance runs. Other data will be collected in support of this and subsequent phases.

The second discrete section will cover design point endurance. The turbine will operate for 1,000 hours at 19,200 rpm with inlet temperatures of 1,550° F and a vapor quality of 90%.

The third segment of the research effort will involve a similar endurance run to determine the accuracy of predictions of blade erosion onset. ■

3,000-KW component test facility.





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FORM BEGINS ON PREVIOUS PAGE

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1.		
Position & Duties		
2.		
Position & Duties		
3.		
Position & Duties		
4.		
Position & Duties		

REFERENCES. Give full names, occupations and addresses. Professional (previous supervisor preferred):

1._____

2._____

Character (other than relatives or former employers):

1._____

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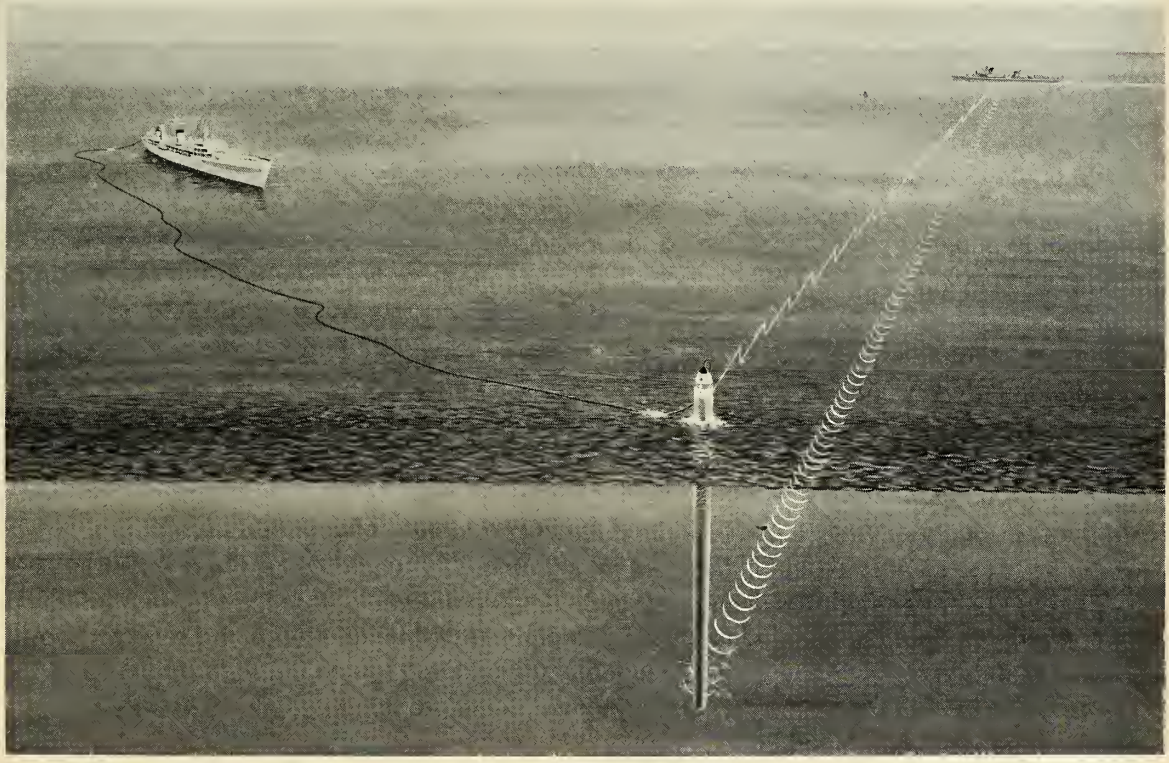
Have you ever been cleared for classified military information_____
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May we contact your former and present employer prior to completion of employment negotiations? Yes_____ No_____.
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Acoustics Research Drone Tests To Aid Navy's Detection Efforts



SPAR IS A stable platform in its vertical attitude at sea. Power is supplied by electrical control cables from tender at left. SPAR receives electromagnetic and acoustic signals from auxiliary ship at far right.

by William Beller

JACKSONVILLE, FLA.—Underscoring the Navy's search for a way to detect nuclear submarines, sea trials will begin here next week of a million-dollar oceanographic drone designed expressly for acoustics research.

Called SPAR—for Seagoing Platform for Acoustic Research—the vessel was disclosed by MISSILES AND ROCKETS nearly three years ago (M/R, Oct. 30, 1961). It is a companion piece to FLIP (Floating Instrument Patform), a manned 300-ft.-draft, cylindrically shaped oceanographic vessel now probing Pacific waters (M/R, July 3, 1961).

SPAR's sea trials will also point up the tendency of large defense contractors to broaden their base of capabilities. In this instance, Aerojet-General Shipyards, Inc., is now SPAR prime contractor as a result of Aerojet-General's recent purchase of Gibbs Shipyards, Inc., of Jacksonville, the original SPAR contractor.

Behind Aerojet's great interest in the sea is the knowledge of the future possible threat of enemy *Polaris*-type submarines poised off a U.S. coast, and the need for an effective way to detect them. This was indicated by E. H. Fletcher, president of Aerojet-General Shipyards during the SPAR christening ceremonies last month: "It is entirely feasible . . . that a great percentage of the future weapon carriers and the required defense capabilities will be conducted beneath the surface of the seas."

The Dept. of Defense is launching an all-out effort to get solutions to some anti-submarine warfare problems. This might include contracting with a nonprofit organization to guide and monitor the work.

Reflecting DOD's interest in the oceanographic part of the ASW problem is the agency's estimated budget of $66.6 million for such work in Fiscal 1965. This is 20% more than the estimated budget of $54.6 milion for DOD ocean study work the previous year.

● **Why SPAR**—The Navy's need to gather oceanographic data for acoustics work covers practically all known variables in the oceans. This is the reason

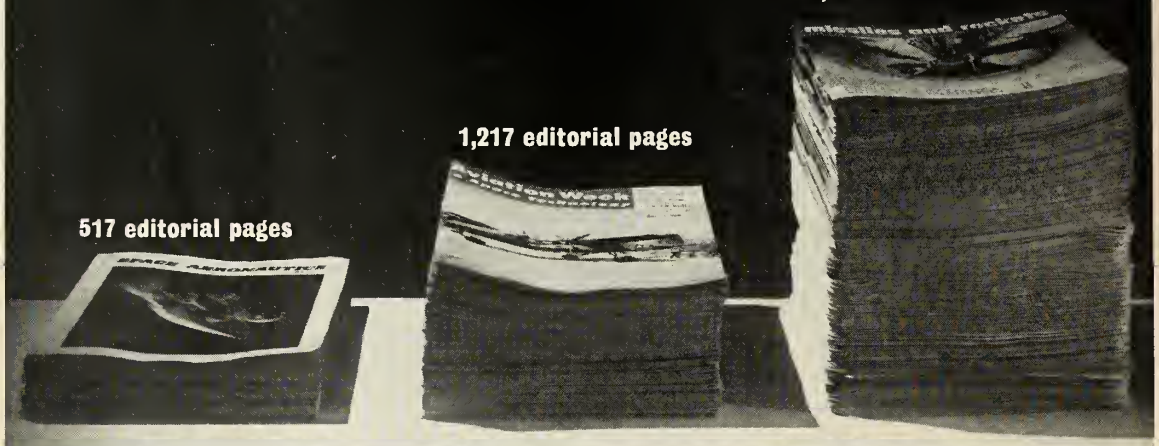
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"SPECIALIZED MEDIA FOR SPECIALIZED MARKETS"

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that first FLIP, and now SPAR, are getting so much Navy attention. They are part of TENOC, the service's ten-year program in oceanography—a scientific assault for gathering data chiefly for ASW.

Of particular interest to the Navy are scattering, reverberation, and absorption characteristics of the ocean; distribution of sound velocities in the oceans, vertically and horizontally; ambient noise; bottom topography and morphology; temperature and salinity distributions in the oceans, vertically and horizontally; internal waves; and ocean and tidal currents.

All of these factors must be defined in terms of locale, season, water depth, bottom contour, regularity and composition (including microstructure), sea state and variation in space and time. Many other characteristics are of interest, and the TENOC goal is to identify, define, understand and exploit them. The Bureau of Ships is the coordinator for the acoustics portion of the military oceanography effort in TENOC.

Efforts aimed at understanding acoustical propagation phenomena in the scientific sense are exerted chiefly by the technical bureau laboratories of the Navy with aid from the Office of Naval Research.

Considerable effort in oceanographic acoustics is also being expended by industrial organizations under contract to the Navy for sonar, torpedo and other developmental ASW/USW equipments. However, the Navy has noted "There is presently no meaningful estimate of the contribution of such organizations to furthering knowledge and understanding of underwater acoustic phenomena on a long-range basis."

● **Description**—SPAR is a 354-ft.-long, 16-ft.-dia., cigar-shaped vessel, towed in the horizontal attitude, then ballasted to a vertical attitude to become a stable platform. It displaces 1,370 tons horizontal, 1,720 tons vertical. Preliminary design was done at the Naval Ordnance Laboratory, White Oak, Md., but the final design was by M. Rosenblatt and Sons, Inc., naval architects and marine engineers of New York. The San Francisco branch of this firm drew up the plans for FLIP.

Gibbs Shipyards was awarded the contract to build SPAR in May, 1963, for a fixed price of $747,277 funded by the Bureau of Naval Weapons. Outfitting the drone and its tenders is expected to bring the vessel's total cost close to a million dollars.

After several days of sea trials, SPAR will be towed to the NOL Test Facility at Solomons, Md., where it is expected to arrive Aug. 25. There it will be outfitted with vertical and horizontal hydrophone arrays, a precision UHF radio direction finder, a gyrocompass, accelerometers, a string of thermistors, and wave-measuring equipment. This work will take about three months, with an additional month required at the Atlantic Underwater Test and Evaluation Center range at Grand Bahama Islands to test the equipment and systems.

● **Attendants**—SPAR operations will require two assisting ships, probably AGORS (oceanographic research ships) operated by the Military Sea Transport Service. One ship will tow SPAR and will be the tending vessel supplying power by means of a 3,000-ft. floating electrical cable. The other vessel will act as the target ship and will transmit electromagnetic and acoustic signals to be received and compared by SPAR. This vessel will operate at ranges from 5-100 miles from the SPAR drone.

Data will be multiplexed for transmission over the floating cable to the tender. A high-capacity data logging system will be installed on the tender for recording data from SPAR. Preliminary analysis will be made on the tender, but detailed statistical analyses of the data will be conducted at NOL.

SPAR is constructed of rolled shell plating stiffened with T-beam longitudinals and transversals. It is subdivided by watertight bulkheads and tank decks into ballast, buoyancy, trim and stability, free-flooding and equipment compartments.

● **How it works**—The attitude of SPAR is controlled by flooding or blowing a tank at the stern. During the change of attitude, stability is maintained principally by shifting salt water ballast between two tanks. Eight small ballast tanks permit adjustment of trim in the vertical position. In addition, there are six free-flooding tanks, open to the sea at all times.

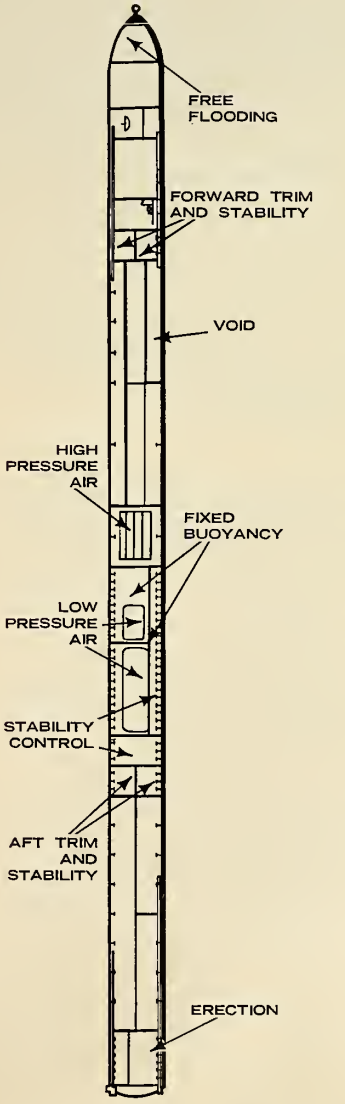
Four machinery spaces are located in the forward end of the vessel. Three are above the waterline when the vessel is in the vertical position. In the forward compartment are a diesel generator for use when external power is not available, air compressors and storage batteries—all mounted on a trunnioned platform.

The next compartment aft contains two radio direction finder antennas and the analyzer for an optical twist measuring device. Next is the electronics compartment where the gyrocompass and electronics instrument racks are trunnion-mounted. The fourth compartment is the pump room and valve station.

A ventilation system will provide automatic heating of the electronics compartment, pump room and machinery compartment, and automatic cooling of the electronics compartment. Emergency blowing of the erection tank is provided for by a high-pressure air system.

● **Aerodynamically clean**—Equipment external to the shell of SPAR has been kept to a minimum to decrease the tendency for the vessel to weathercock due to wind while in the vertical attitude. Hydrophone bents are located at the stern and 50 ft. from the stern extending 25 ft. out from the centerline in each direction. Hydrophone mounting rails extend forward from the stern 200 ft.

To orient the SPAR about its logitudinal axis when in the vertical position, a rotation system is installed. A 5-hp motor drives a small, reversible propeller mounted on the skin. ■



COMPARTMENTATION OF SPAR.

Oxygen-Helium Atmosphere Appears Promising for Manned Space Flight

Results of Purdue Research Facility study show that mixture may assist astronauts in case of spacecraft decompression

by Heather M. David

USE OF A MIXTURE of helium and oxygen in a space vehicle atmosphere may offer advantages in prolonging the life of astronauts in case of decompression, a group of scientists says.

A group at the Purdue Research Facility, led by Dr. James Witherspoon, indicates that helium could be the best choice as an inert diluent for oxygen, if research done on mice can be extrapolated to humans.

The biggest point in favor of helium over nitrogen is that it does not readily form gas bubbles in the blood during decompression, and thus does not cause "bends." Helium has the same advantage as nitrogen in that it does not support combustion, presenting much less fire hazard than does 100% oxygen. One difficulty with the gas, however, is that voice communications become difficult through a helium-rich atmosphere.

In a recent issue of the *Journal of Aerospace Medicine,* the Purdue group reports that it studied three different kinds of spacecraft atmosphere mixtures: oxygen-nitrogen, oxygen-helium, and oxygen-argon.

Several hundred adult male mice were divided into three groups and put into flasks containing one of the three mixtures. In each experiment, the gases were circulated in the flasks for several hours to insure that the tissues became saturated. Oxygen occupied about 20.95% of total volume in all three cases.

Several types of experiments were conducted, involving both slow and rapid decompressions.

● **Results**—Oxygen consumption and carbon dioxide production was somewhat higher in both helium and argon mixtures than it was in air. The mice were physically active to about the same extent in the three mixtures. Body temperatures in helium-oxygen were generally lower than in air, and dropped more quickly to lower levels after slow decompression. (Slow decompression was given as 100 mm Hg/min., to 179 mm Hg, 35,000 ft.).

Results seem marked. In one experiment, six mice decompressed in air survived an average duration of 1.6 minutes, while eight decompressed in helium-oxygen survived an average of 7.7 minutes. In other tests, the difference was not quite as great, but the helium-oxygen group showed a survival time factor several times as great as the others.

The increased minutes could allow the astronauts to repair damage or take emergency measures that might otherwise be impossible.

In the rapid decompression test, to pressures ranging from 60 to 220 mm Hg in one to two seconds, the helium mixture did not appreciably alter survival time except when the pressure was reduced to 80 mm Hg, in which the difference was only small.

● **Conclusions**—While a number of theories attempting to explain the phenomenon are discussed, the authors appear to favor the idea that helium's greater thermal conductivity promotes a greater reduction in body temperature, and thus a resistance to hypoxia.

This is borne out by the fact that the average body temperature of mice in a helium-oxygen mixture was 2°F lower than in air, and when death occurred, it was 3.9°F lower.

If this reduced body temperature must occur to promote survival during decompression, the helium-oxygen mixture probably will not be of benefit during rapid decompression, since the body will not have had time to adjust.

● **Greater energy storage**—Another experiment was conducted by the researchers to determine what the energy stores are in the various oxygen mixtures. In this instance, an acid that causes the animal to become anoxic and starves the tissues of oxygen, was injected into the mice. Survival time was thus dependent upon the amount of high-energy phosphate and oxygen stored in or entering their brains.

The researchers again report that the mice survived somewhat longer in the helium-oxygen mixture than in oxygen-nitrogen. This could result from several things, they said: more oxygen may be stored in the tissues saturated with helium; more high-energy phosphate may be synthesized or stored; energy sources may be depleted to lower levels before death, or energy utilization in the tissues may be reduced.

If it is true that more energy is stored in the helium-oxygen environment, it could be especially significant for man, the group concluded. ■

High Temperature Cited In Oxygen Sensitivity

HIGH TEMPERATURES appear to significantly increase the sensitivity of living things to 100% oxygen.

Profound detrimental changes occur in the lungs of mice, reports a group of researchers headed by Dr. Armand J. Gold, formerly with General Electric Co. and now with the Martin Co.

The combined effect is most evident at 87°, 90° and 100°F. Groups of mice that breathed normal air tolerated these temperatures with only slight effects after long duration, they said. Experiments were conducted with both mice and amoebae, to study whole-animal and cellular effects.

Pure oxygen will be used in *Gemini, Apollo* and probably in the Air Force *Manned Orbiting Laboratory* programs, with mixed gases favored for longer-duration missions.

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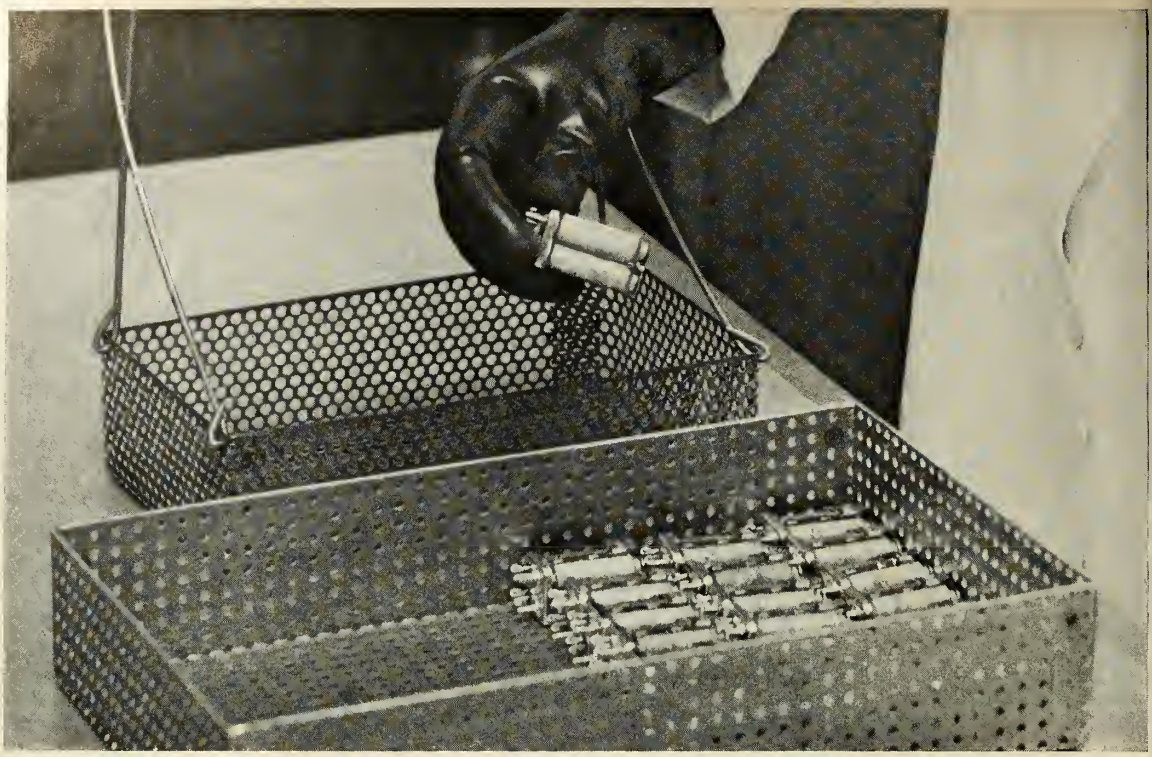
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Mergers and Acquisitions

Microwave Electronics Corp., Palo Alto, Calif., has reached agreement with Sylvania Electric Products, Inc., to acquire Sylvania's Traveling Wave Tube operation at Mountain View, Calif. MEC will continue to operate the facility in Mountain view for three to six months until it can be consolidated into the MEC operation in Palo Alto. Sylvania will retain its Eastern Microwave operation at Williamsport, Pa. . . . *Genisco Technology Corp., Compton, Calif., expects to complete plans in the near future to acquire Jamieson Industries, Inc., Van Nuys, Calif. Jamieson produces transonics, magnetic component, antisubmarine warfare and other commercial and military equipment.* . . . Directors of Federal-Mogul-Bower Bearings, Inc., Detroit, and Sealed Power Corp., Muskegon, Mich., have submitted to shareholders a plan to merge the two firms. Vote on the proposal is set for Sept. 28. If the merger is approved, Sealed Power would become a division of Federal-Mogul-Bower. . . . *D-Cemco, Inc., Upland, Calif., manufacturers of electronic hardware, has purchased Lincoln Instrument Co., Inc., and its Circuit Structures Lab Div., manufacturers of electronic hardware for printed circuit design, packaging and production.* . . . The Bendix Corp. has entered a contract to acquire the business and assets of Dage Electric Co., Inc., of Franklin, Ind. Dage makes RF coaxial cable connectors, precision glass-to-metal hermetic seals and other electronic parts for the missile/space, aircraft, automotive and electronic component industries. The firm will continue operation in Franklin as a wholly owned subsidiary of Bendix. . . . *Basic Industries, Gardena, Calif., has acquired Flow Systems, a Los Angeles control valve engine ring and manufacturing company, from Royal Industries, Inc., Pasadena, Calif. The newly bought operation will be renamed Modern Flow Systems and incorporated into the Los Angeles plant of BI's Modern Precision Div.*

New Activities

Magniscope Manufacturing Co. has been formed in San Mateo, Calif., to manufacture and market precision optical devices for industry. Initial products will include a low-cost optical comparitor for shop and assembly-line applications. . . . *Genistron, Inc., a subsidiary of Genisco Technology Corp., has established an Applied Research Div. in Washington, D.C. Activities are to be directed to R&D efforts in electromagnetic radiation, compatibility, and RF interference as defined in Project HERO.* . . . Manson Electronics Div. of Hallicrafters Co., has formed a Heavy Electronics Section to be concerned with nuclear instrumentation, magnetic components, high power microwave modulators, and power supplies. Activity will be at Wilton, Conn. . . . *Eastern Stainless Steel Corp., Baltimore, has established a new Plate Products Div. to be devoted to processing and handling of stainless steel plate exclusively. The division will occupy a new facility adjacent to the firm's mill property.*

International

Walter Kidde and Co., Belleville, N.J., has opened a new European office in Geneva to market Kidd products, including aerospace systems, pneumatic controls, air compressors, and fire detection and extinguishing equipment for ships, planes and armored vehicles. . . . *Itek Corp., a Lexington, Mass., specialist in information technology, has formed a Canadian subsidiary, Itek Business Products, Ltd., in Toronto.* . . . Simmonds Precision Products, Inc., Tarrytown, N.Y., has formed a wholly owned subsidiary in England to produce electronic measurement, display, control and communication systems now being manufactured in the U.S. and The Netherlands.

LTV in Tax Fight

In Dallas, the city board of equalization has ruled that Ling-Temco-Vought must pay taxes on $17 million worth of equipment and tools it leases from the Bank of America. The Bank fought the assessment, contending that Federal law prohibits local municipalities from taxing property owned by a National bank located in another state. A Dallas tax official says the equipment had belonged to LTV, which sold it to the Bank of America last December and then leased it back the same day. The case is expected to continue in the courts.

Industry Facilities

Avco Corp.'s Research and Advanced Development Div. has announced plans to more than double the size of its Industrial Products Subdivision facilities in North Wilmington, Mass. . . . *The Linde Div. of Union Carbide Corp. plans to build a $5-million plant near Titusville, Fla., to manufacture liquid hydrogen, oxygen and nitrogen for use at Cape Kennedy and the Merritt Island Launch Area. Production there is expected to reach 400 tons a day after completion of construction in about a year.* . . . Clark University, Worchester, Mass., will name its new library the "Robert Hutchings Goddard Library" in honor of the late space pioneer. . . . *Humble Oil and Refining Co. has announced plans to develop 7,250 acres of land adjoining the NASA Manned Spacecraft Center near Houston to be used as a waterside industrial district. Called Bayport, the area will assure Clear Lake City industries access to the Houston Ship Channel and the Gulf of Mexico.* . . . HRB-Singer, Inc., an electronic research and development subsidiary of The Singer Co., is establishing a laboratory facility at Reston Center for Government and Industry, Fairfax County, Va.

S-Band System Subcontractors To Collins To Be Named This Month

by Charles D. LaFond

UNIFIED S-BAND system subcontracts from Collins Radio Company's Dallas Division will be finalized late this month.

Following the firm's selection as prime contractor by Goddard Space Flight Center last June 17 and completion of negotiations June 29 for the nearly $22-million fixed-price/incentive contract, Collins began in-house subsystem design while awaiting final sign-off by NASA Headquarters.

Under its present schedule, the company told MISSILES AND ROCKETS it plans to complete the first of nine S-band tracking and data-acquisition systems, using a 30-ft.-dia. paraboloidal-reflector antenna, and install it at a Dallas test facility by late spring, 1965. This station equipment will be used for test and evaluation initially, but will later be installed at a station in the global network (M/R July 20, p. 20).

A single antenna/dual S-band system (for *Apollo* Lunar Excursion Module and Command Module support) will be shipped to Carnarvon, Australia, for installation by late spring, 1966, the firm disclosed.

In addition to the nine stations (four single and five dual S-band systems), Collins will provide some 30 partial systems, which will be used aboard the planned new tracking ships (five), for the three Goddard 85-ft. antenna stations and for spares.

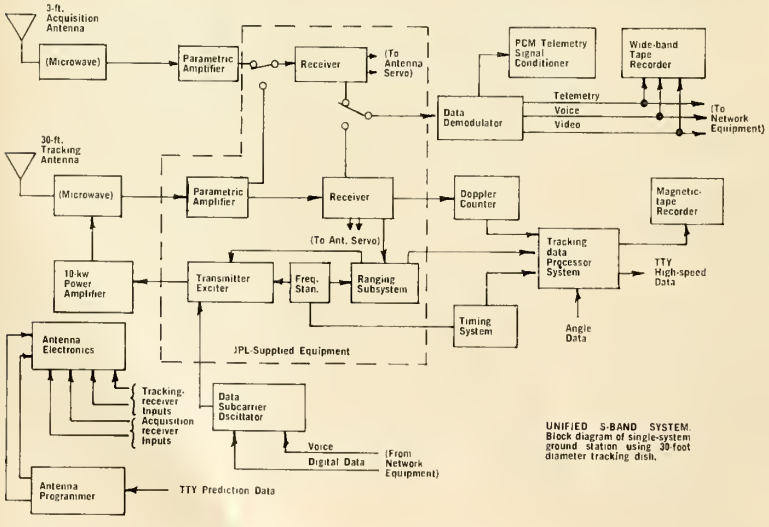
The last of the 30-ft. systems is scheduled for shipment at about the time of first-system acceptance at Carnarvon by Goddard. Contract completion is expected by the winter of 1966-67, according to Collins.

• **Systems design**—The new unified S-band system does not embody the use of a new approach or even a new frequency for NASA. It does, however, employ to the maximum global network equipment already in use, and it will be designed to employ subsystems and techniques developed and successfully used by the Jet Propulsion Laboratory in its Deep Space Instrumentation Facility.

The system, according to Goddard, is "unified" to the extent that a single system will provide two-way tracking data and both voice and data communications between the global ground net and the *Apollo* spacecraft at all times—either during its Earth-orbital phase or during the trans lunar missions.

Three basic station types will be used: a 30-ft.-dia. antenna with single S-band systems for Command Module Earth orbital contact; a 30-ft. antenna with dual S-band system for Earth orbital and lunar missions (for Command and Lunar Excursion Modules); and an 85-ft. antenna for coverage beyond 12,000 miles. the smaller dishes will serve as backup even over the lunar range.

A single carrier frequency for each direction of transmission will be used for the tracking, telemetry and communications modes. the transmitted and the received signals will be coherently related. Measurements of the carrier Doppler frequency shift will be used by ground stations for determining the position and radial velocity of the craft.



UNIFIED S-BAND SYSTEM. Block diagram of single-system ground station using 30-foot diameter tracking dish.

Ground transmitted voice and update data signals will be modulated onto subcarriers and then combined with the ranging signals. The composite will be employed to phase-modulate the transmitted ground carrier.

The subcarriers will be extracted from the RF carrier in the spacecraft transponder and processed to produce the clear voice and data signals. A wideband phase detector will detect ranging signals, translate and direct to the down-link carrier.

Spacecraft-transmitted voice and telemetry data will be modulated onto subcarriers, and then combined with the video ranging signals. Again, the composite is used to phase-modulate the down-link carrier frequency.

The transmitting position of the spacecraft transponder can be frequency modulated for TV transmissions or for sending recorded data (instead of ranging data) to the ground.

● **Operation**—The 30-ft. tracking dishes will carry a 3-ft.-dia. acquisition antenna (see photo) projecting outward from the lower periphery of the structure. This smaller dish will operate on the carrier component of the received signal, direct the whole received signal and direct the entire structure through an antenna servo system.

The acquisition system electronics, which include a parametric amplifier and receiver, can also be used to back up the primary system electronics in case of failure.

The primary tracking system directs inputs from the receiver into a data demodulator and into the JPL-type ranging system.

The Collins-supplied portions of the system, together with the government-furnished equipment, will be integrated by the firm into a complete system capable of:

—Acquiring and tracking spacecraft signals, at about 2287 mc.

—Transmitting voice, data, and range and range rate signals to the spacecraft, at about 2106 mc.

—Transfer track after acquisition to the primary antenna system and lock onto the spacecraft transponder signal.

—Determine spacecraft range and range rate and record and/or direct the data to the NASA communications network.

—Receive via teleprinter orbital parameters from Goddard control center and convert the data into antenna position commands to drive the antenna.

—Provide a visual read-out of the antenna pointing angles for recording and/or transmission into the Goddard communications network.

● **Antenna system**—The 30-ft. antenna will have a Cassegrain feed system and a solid paraboloidal reflector surface. The system will have a 12-ft. focal length.

The reflector structure, supported on a two-axis X-Y mount, will carry the feed and diplexer components, 3-ft. acquisition antenna, 2300-mc parametric amplifiers and converters, and supporting electronic connections and temperature control components.

Antenna designs will include tracking rates from 0-4°/sec. with accelerations up to 5°/sec.[2] The structure will have to withstand wind loadings up to 70 mph in any position, up to 140 mph in the stowed position.

Except for a 10° lower limit in the north-south directions, the antenna mount will permit tracking in all directions above a horizon of 2°. (The N-S keyholes are semicones with a maximum horizontal width of ±10°. In the east-west directions, the antenna will be capable of 0° elevation.)

Goddard requirements call for an overall antenna system noise temperature of 40°K. This includes termination in a 2-db noise figure preamplifier, an effective noise temperature of 15°K at the receive feedhorn output and an antenna noise temperature of 25°K.

The Cassegrain sub-reflector will employ a hyperboloidal surface. The composite feed will permit transmitting and receiving in the 2-gc range (2090-2120 mc) at 10 kw average power, receiving the spacecraft beacon signals (2270-2300 mc range), and provide a monopulse feed producing beacon-frequency outputs for sum, x-error, and y-error channels. The antenna design will allow for instantaneous peak power to 20 kw without voltage breakdown.

Overall antenna gain (using the transmit feed input), according to Goddard, will be at least 43-db above isotropic at any frequency in the operating range. Sidelobe levels will have to be 20 db below the peak of the main beam for the secondary pattern of the antenna.

Overall gain at the receive output feed will be 44-db above isotropic throughout the operating band and sidelobe limitations will be similar to transmit requirements.

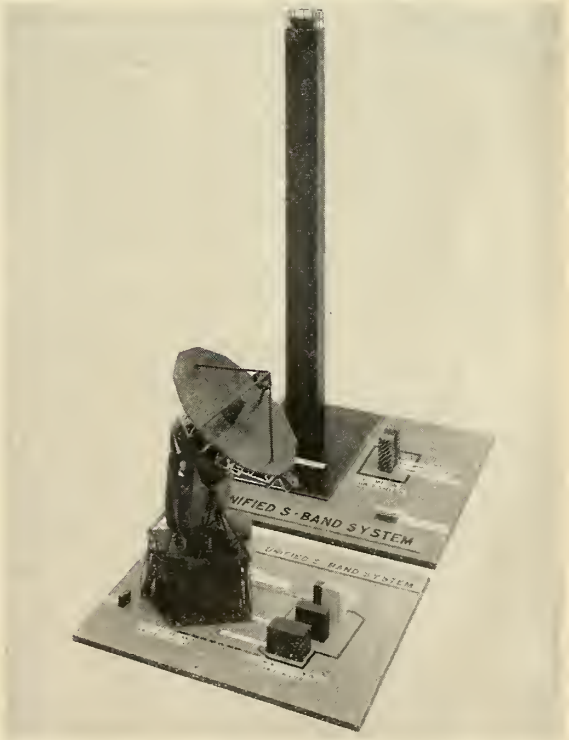
The tracking feed will produce half-power beamwidths of the sum channel secondary patterns of between 0.8° and 1.3°.

Size-weight requirements for the diplexer-filter system call for 15 lbs. total and approximately one cubic foot in volume. The dry-nitrogen pressure system will be maintained at 10 psi.

A tracking accuracy of 0.5 degree will be required of the small 3-ft. acquisition antenna, which will be attained by using an amplitude monopulse feed in both planes. Antenna gain will be held to a minimum of 22 db for the sum channel.

● **Other subsystems**—Collins will develop and build 15 other major subsystems, including an acquisition tracking receiver, parametric amplifier-converter system, antenna position programmer system, and a tracking data processor system.

The latter will be a 75-ft.-high structure, to be located 3,000 ft. from the 30-ft. receiving antenna. The collimator tower will serve as a stable mount for a boresight antenna and an optical target, which, together with an optical system on the main antenna, will be used to determine the pointing direction of the 30-ft. dish's radio axis relative to its physical axis. ■



SCALE MODELS of unified S-band system 30-ft. tracking & communications antenna (foreground) and 75-ft.-high collimation tower. Nine will be provided for Goddard by Collins Radio Co.

Digital Television System Is Heart of Mariner Spacecraft Slated for November Mars Fly-by

by Rex Pay

PASADENA, CALIF.—*Mariner Mars*, due to be launched on its 140-day interplanetary journey next November, is intended to pass within 11,200 miles of the surface of Mars and record details less than two miles in diameter by means of a digital television system.

Twenty pictures of a series of areas 200-mi. square across the face of the planet are hoped for during the fly-by of the planet by the 500-lb. spacecraft. Pictures will be taken alternately through green and red filters.

Total cost of development of two spacecraft and a spare for the 1964 mission has been estimated at $104 million.

During fly-by, television data will be stored on magnetic tape. This data will be played back slowly over a period of 10 to 20 days after encounter to provide the extremely low data transmission rate that must be used over the interplanetary distance of about 62 million miles.

It is the extremely low communications bandwidth available that has led to the use of a digital television technique for the first time in space missions.

A Type 1343-010 one-inch vidicon tube made by General Electrodynamics Corp. forms the heart of the *Mariner* system. It has a selenium compound target of high resistivity, capable of storing images for 24 seconds without degradation. The vidicon looks through a 12-in.-focal-length Cassegrain telescope with an effective aperture of f/8 and a 1-degree field of view.

● **Description**—*Mariner Mars* is an octagonal spacecraft with four 6 x 3-ft. solar panels attached in cruciform arrangement to its upper face and a television camera mounted in the corresponding octagonal space on the opposite side. The camera is mounted on a mechanical scanning platform. Seven of the octagonal faces carry equipment; the eighth houses the mid-course propulsion nozzle.

A mast carrying high- and low-gain antennas extends from the face holding the fixed solar panel arrays. In flight the side with the mast points toward the Sun and is stabilized in roll about this axis by reference to the star Canopus. The television camera points away from the Sun.

In the nominal trajectory used for camera system design, the spacecraft flies at a speed of 5±3 km/sec at 30-degrees to the Mars-Sun line. The Camera is mounted at 60 degrees to the spacecraft-Sun line and therefore looks out at a 90-degree angle to the trajectory as the spacecraft flies by Mars.

About six hours before fly-by, at a distance of some 67,000 mi. from the planet's surface, power will be supplied to the television system, activating the vidicon tube filament and all electronics. At the same time, the mechanical scanning platform on which the camera is mounted is started. Attached to the platform are wide angle and narrow angle planet sensors.

When the planet enters the view of the wide angle sensor, the scan amplitude reduces and acquisition by the narrow angle sensor takes place, followed by lock-on to the planet.

The intention is to lock on to the farthest bright leading edge of the planet, so that the television camera will track across the greatest diameter.

● **Camera activiation**—At wide-angle acquisition of the planet, the sensor provides a signal to the science data automation system (DAS) on the spacecraft. This in turn initiates picture-taking by the television camera. Pictures of deep space are then obtained, which are not recorded.

When the planet surface comes into view of the camera—recognized by a rise in signal intensity from one scan line—a 1.2-kc signal from the camera logic passes to the DAS. This then initiates the sequence of picture-taking and recording.

Calculations show that false initiation of picture-taking by Martian satellites Deimos and Phobos is extremely unlikely.

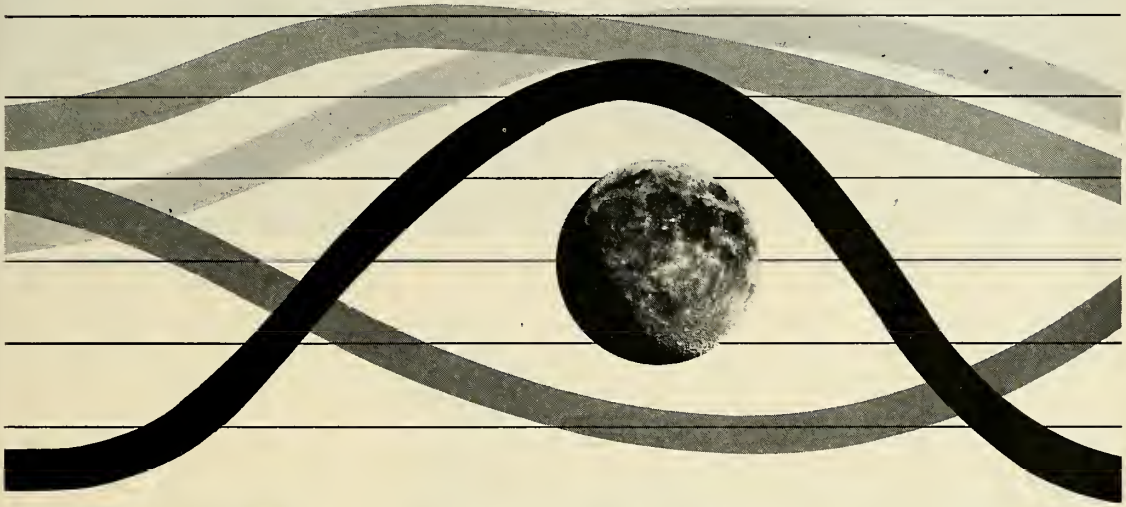
The intention is to obtain 10 pairs of overlapping pictures. In each pair, one picture overlaps the other by one-third of the picture width. A similar distance separates each overlapping pair. One picture of each pair is taken through a green filter, the other through a red filter.

SCOPE

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SR. MECHANICAL ENGINEER (Ordnance and Safety)—10 to 12 years' experience in evaluating mechanical ordnance support systems and airframe mechanisms.

SYSTEMS ANALYSIS ENGINEER—Experience in the analysis of measurement and telemetry systems, both airborne and ground, with particular emphasis on accuracy, validity and techniques for spacecraft sensors and transducers.

TELEMETRY DESIGN ENGINEER—AIRBORNE—Related experience in design of airborne telemetry systems—PCM and general airborne system design required.

CHECKOUT ENGINEER—3 years' experience at launch sites preferably with R&D vehicles, including a familiarity with digital systems. Additional experience should be in one or more of the following areas: RF systems, switchgear, patching systems design, or ground electric systems.

SR. PROGRAMMER ANALYST—Experienced in use of digital computers with information or automatic checkout systems. Background in planning, development and implementation of complex programming and real time systems for depth analysis, engineering support and translation of requirements to computer-oriented specifications.

ANALOG DISPLAY ENGINEER—Experience in design and development of specifications for analog and alphanumeric display equipment.

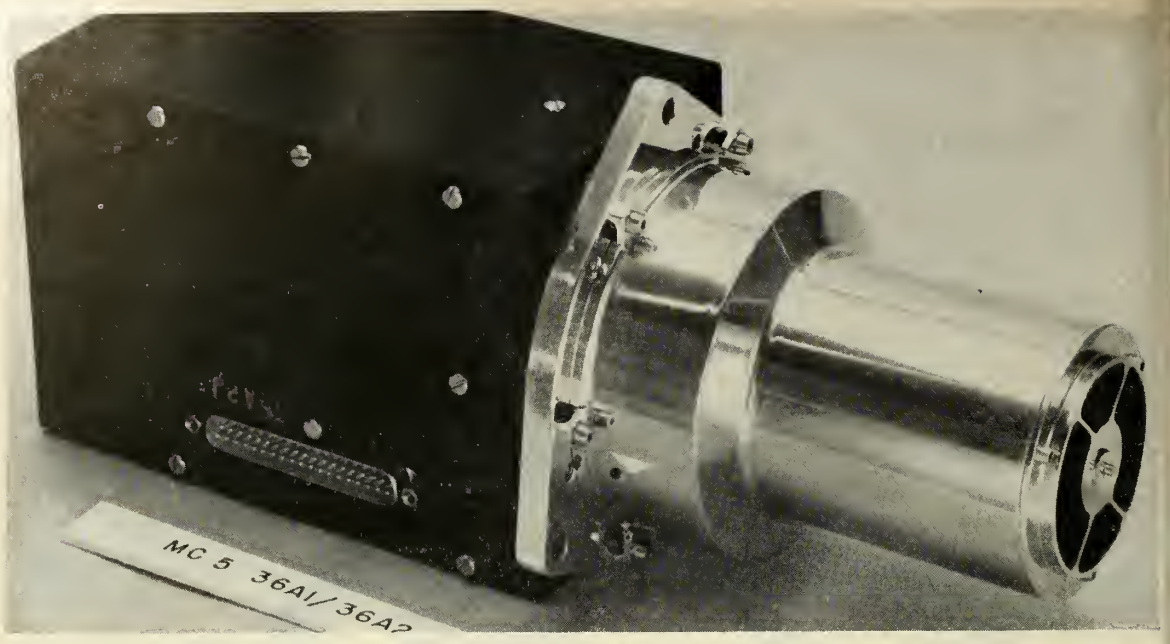
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Please write in strict confidence, including salary requirements, to: Mr. P. W. Christos, Apollo Support Dept., Room 1111-F, General Electric Co., P. O. Box 2500, Daytona Beach, Florida.

GENERAL ELECTRIC

An Equal Opportunity Employer

Circle No. 3 on Subscriber Service Card



MARINER MARS spacecraft television subsystem shows camera head and optics subassemblies. Critical element in the system is a one-inch vidicon tube made by General Electrodynamics Corp., which can store images for 24 secs. with degradation.

There will be no attempt to obtain color pictures of Mars. The filters are simply intended to aid interpretation of the transmitted pictures.

● **Electrostatic tube**—The *Mariner Mars* television system uses a single all-electrostatic tube, which weighs 2 lbs. less than an all-magnetic system. The camera head weighs about 3½ lbs., the total television system weighing 11 lbs. A 200-line raster covers a square area of 0.22 x 0.22 in. on the vidicon faceplate. Scanning takes 24 seconds, as does erasure. Flashing a light on the target to effect erasure and priming is not required, a "random scanning" technique being used instead.

A vertical and horizontal resolution of at least 140 TV lines can be expected if a "Kell" factor of 0.7 is assumed. Active line time amounts to 15 millisec. To generate a 24-sec. frame, a 105-millisec. deadtime is inserted into each line. Normal rapid flyback of the scanning spot is used.

In an analog-digital converter in the camera system, each television line is divided into 200 words, with six bits allotted to each word. That is, each of 200 points along the television line will be specified as being at one of 64 different brightness levels.

Nominal exposure time for each picture on the vidicon target is 200 millisec., a figure chosen so that picture resolution will not be limited by smear due to spacecraft motion.

A rotating disc containing four cutouts housing red and green filters is contained in the optics subassembly in front of the vidicon. A filter is brought into the light path by a solenoid and remains there until the exposure is terminated by a second pulse. Eight pulses cause complete rotation of the filter wheel.

● **Shutter design**—The shutter design provides an exposure range of 100 to 500 millisec. This, plus the ability to vary video amplifier gain in the television system, provides an overall capability of adjusting system response to meet a 64:1 range of illumination on the planet's surface. That is, the shutter adjustment extends the effective control range of video gain to 64:1.

Automatic adjustment of video level is carried out by a logic unit that exercises control in discrete digital steps and automatically decides whether adjustment of shutter time or amplifier gain is required. Telemetry of critical television system potentials will aid in picture interpretation and give an indication of light levels on Mars. The system has been calibrated for this.

At acquisition of the planet by the television system, the control grid voltage is automatically changed from an acquisition level to another level. This prevents the sudden emergence of the bright planet disc from saturating the system and giving a hung-up or inverted condition.

Analog-to-digital conversion in the television system uses a linear ramp method, with a 1-mc. clock. The encoder accepts analog signals in the 0 to 10-v range.

● **Information capacity**—Total information per television line amounts to 1,200 data bits, which appear in a 15-millisec. burst followed by 105 millisec. of deadtime. A sonic delay-line rate-buffer in the DAS accepts the burst (which emerges from the TV system with an effective data rate of 80,000 bits per second, and converts it into a steady stream of data at 10,700 bits per second). This stream is recorded in a magnetic tape recorder capable of storing 20 pictures, or 4,800,000 bits.

The DAS system will provide a 31-bit pseudonoise sequence that identifies each data-bit sequence with a line and frame number. Grid voltage will be recorded for each frame.

Line scanning in the television equipment starts on receipt of line synchronization pulses originating from the science data automation system. An incoming line-start pulse sets a control flip-flop coupled to the camera control logic, energizing sweeps and various control gates. The same flip-flop gates a 1-mc crystal oscillator and enables the data-conversion programmers to accept bursts of television data. The crystal oscillator, located in the TV subsystem, provides the basic timing for the logic of the whole system.

Two hundred synchronization pulses are used during picture data readout and 200 are used to prepare the vidicon target surface for the next picture. That is, one picture can be taken every 48 seconds.

The final data rate, as transmitted from the spacecraft to the Deep Space Instrumentation Facility antennas, is 8⅓ bits/sec—or one picture element in just under a second. Transmission is in digital pulse code modulation. ■

Voltage Reference Supply

Dynage, Inc., is marketing a line of constant voltage reference supplies designed to supply a 10-v dc precision voltage to a Kelvin Varley voltage divider with resistances of 1,000, 10 or 100 K ohms.

The combination will provide an adjustable 0 to 10v dc voltage standard source, a 0 to 10v dc precision bias supply or a 0 to 10v dc precision potentiometer when used in conjunction with a null detector. Voltage regulation is ±5 ppm for a ±10% input change. Temperature coefficient is ±5 ppm/°C. Resolution of output voltage adjustment is 1 ppm.

Circle No. 151 on Subscriber Service Card

D-C Amplifier

A 30-kc bandwidth, singe-ended d-c amplifier, the Model 6460, is being marketed by Dynamics Instrumentation Co.

The solid-state unit has a variable gain up to 1,000 and drift of ±5 μv without use of a chopper. Potentiometric feedback provides noise of 5 μv and input impedance of 100 megohms. Recovery from overload is less than 1 millisec. Output is 100 ma at ±10v. Power requirements are 105 to 130v, 60 cps, 8 volt-amperes.

Circle No. 152 on Subscriber Service Card

Microwave SPST Switch

A miniature microwave SPST switch, the Model DS 532, is being marketed by Sanders Associates, Inc.

The solid-state device offers high OFF isolation, typically 50 db, and will exceed 40 db over the entire broadband range from 4 to 8 gc. It will handle up to 1 watt of power, and has an operating temperature range of—54° to 70°C. Insertion loss is 3 db maximum over the complete band.

Circle No. 153 on Subscriber Service Card

Impedance Measurer

A system for direct measurement of electrical impedance of an unknown under high power and variable frequency has been developed by Dranetz Engineering Laboratories, Inc.

The system includes the Model 100B impedance meter and Model 100-PA-1003 adapter model and uses an external signal from a power amplifier. Maintaining a constant amplitude of ac current through the unknown, it monitors the voltage developed. This voltage is resolved into in-phase and quadrature outputs and is presented on resistance and reactance meters and on output terminals for automatic X-Y or strip chart recording.

Specifications include: frequency range—100 cps to 25 kc; preselected values of constant current—0.01, 0.03, 0.1, 0.3, 1.0 and 3.0 amps RMS; full scale impedance ranges—10 ranges from 5 to 10,000 ohms; and a 1,000v RMS maximum voltage across the unknown.

Circle No. 154 on Subscriber Service Card

Microminiature Switches

A line of microminiature switches, capable of switching in less than 1 millisec. from the instant of current application to the bridge wire, is available from Aerospace Components Div. of Atlas Chemical Industries, Inc.

The MMS series has both ends hermetically sealed with glass-to-metal seals. The explosive used to actuate the switches is KDNBF, a lead-free charge leaving no conductive particles. The MMS 1.0 is a single pole, normally open switch; MMS 1.1 is a single pole, normally closed model. Multi-pole and sequencing switches are available on order.

Circle No. 155 on Subscriber Service Card

Pulse Trigger Packages

A line of pulse trigger packages for military and commercial radar applications is being marketed by Protran Co., Inc. Each package consists of charging-choke, pulse-forming network and pulse transformer.

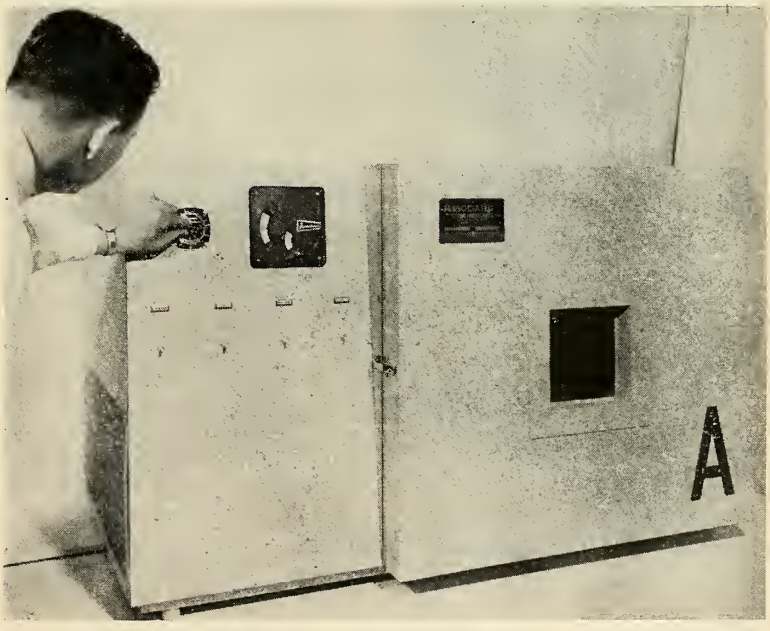
Typical electrical output characteristics include: pulse width (at 70% amplitude) at 2 microsecs; amplitude of 1,000v maximum; impedance of 70 ohms; and pulse repetition frequency of 1,500 pps maximum.

Circle No. 156 on Subscriber Service Card

Charge Amplifier

The Model FT-0001 charge amplifier, designed to withstand environments encountered in missile test stand applications, is available from Gulton Industries, Inc.

With a "front end" design, the use of up to 1,000 ft. of low-noise coaxial input cable results in less than 1% change in sensitivity. Operating temperature range is 0 to 130°F. The unit operates at vibration levels up to 10 g's



New Product of the Week: Refrigeration Test Chambers

Associated Testing Laboratories, Inc., has announced two larger models of its Econ-O-Cade cascade refrigeration test chamber. The units are available in sizes of 5 and 8 cu. ft. of working volume.

Temperature range is —100° to 350°F with ±2°F control accuracy. A liquid CO_2 injection system is also included for rapid pull-down requirements of thermal shock testing. Both models are table top and feature thermopane window and feed-through ports. Price of the 5-cu.-ft. model is $1,785; the 8-cu.-ft. model is priced at $2,495.

Circle No. 157 on Subscriber Service Card

peak and can withstand 30 g's shock for 5 millisecs. Each amplifier module has a self-contained 115v, 60 cps, power supply.

Circle No. 158 on Subscriber Service Card

Coaxial Transfer Relay

Jennings Radio Manufacturing Corp. has available the Model RC53 vacuum coaxial transfer relay, offering the advantages of a vacuum dielectric in a four-pole (two inputs, two outputs) contact configuration.

The unit offers a constant impedance



in 50-ohm circuits, and may be either remotely or manually controlled. Electrical specifications include a frequency range of 0 to 600 mc and power rating of 4 kw cw average at 30 mc. Crosstalk is greater than —70 db at 60 mc; VSWR is 1:1.1 maximum through 600 mc.

Circle No. 159 on Subscriber Service Card

Piezoelectric Accelerometer

Consolidated Electrodynamics Corp. has introduced a piezoelectric accelerometer featuring a "shielded compression" design that protects the seismic crystal from effects of acoustic bombardment, cable whip and thermal transients.

The Model 4-273 has all-welded construction and is said to be particularly suited to operation in severe humidity, meeting MIL-E-5272C specifications. The device can be used for dynamic acceleration up to 5,000 g's; frequency range is 2 to 10,000 cps. Temperature range is —100° to 350°F.

Circle No. 160 on Subscriber Service Card

Power Controllers

Fostoria Corp. is marketing a line of Model I power controllers for proportional control of electrical loads of 100 to 1,800 amps at voltages up to 600v.

The units will sustain at least a 20X overload (based on a 15% duty cycle) without damage. Solid-state circuit firing eliminates need for warm-up. Off-the-shelf models include current ratings of 100, 280, 480, and 1,800 amps, 600v, for 60, 50 or 25-cycle operating.

Circle No. 161 on Subscriber Service Card

Magnetostrictive Delay Lines

The HTDL series of magnetostrictive delay lines, said to be capable of "storing" twice the amount of digital information of comparable devices, is available from General Instrument Corp.

The lines can operate in shocks up to 80 g's and have operating frequencies up to 4 mc in the NRZ mode with delays of from 60 to 1,500 microsecs. Digital serial memory capacity is 6,000 bits. Operating frequencies up to 5 mc can be attained in lines of 10 to 60 microsecs. All lines are adjustable to ±2 microsecs.

Circle No. 162 on Subscriber Service Card

10-Watt TWT

Huggins Laboratories, Inc., has introduced a traveling wave tube with a 15-db maximum noise figure and 35-db minimum small signal gain. The Model HA-109 features 10 watts minimum saturation output power over the octave band of 1 to 2 gc. The unit is first in a line of low-noise, PPM focused TWT's.

Circle No. 163 on Subscriber Service Card

Solid-State Inverters

Single-, split- and three-phase solid-state inverters with output capability ranging from 50 va to 10 kva are available as standard units from the Avtel Corp.

The units feature dynamic load adaptability, overload protection and absence of RFI and acoustical noise. Standard outputs are 60, 400 and 800 cps. The Series 300 provides output voltage and frequency held constant within ±1% and 0.1% respectively. Incidental AM is less than 1% peak-to-peak. Output distortion varies from 0.75 to 5% THD depending on unit and frequency.

Circle No. 164 on Subscriber Service Card

Punched Tape Reader

Cook Electric Co. is marketing a photoelectric punched tape reader for "on-line" service in computer, communication and control applications. The solid-state device is designed to *Minuteman* missile and MIL-E-4158B specifications.

The Model 92 has a 200-character/sec. bidirectional reading speed and a 600-character/sec. bidirectional search and rewind speed. Stepping rate is asynchronous at any rate up to 80 characters/sec. at reading speed. Start time is 22 millisecs. to within 10% of nominal speed.

Circle No. 165 on Subscriber Service Card

Sequence Programmer

Astro Technology Corp. is marketing a sequence programmer that provides control accuracies to 0.1 millisec.

The Model ST-1 timer provides time intervals by means of a self-contained 100-kc crystal frequency reference oscillator. This drives a 7-decade counter that can be operated at 1 or 10 kc for maximum total times of 9999.999 seconds or 999.9999 seconds.

Circle No. 166 on Subscriber Service Card

Phase Generator

Theta Instrument Corp. has available the Model PG-3 phase generator designed to provide continuous phase shift of a carrier voltage without amplitude change.

The unit operates from —40° to 55°C. Other specifications include a phase accuracy of 30 minutes of arc; input of 110v; output, 32v; range, 0 to 360° continuous and dial resolution, 6 minutes of arc.

Circle No. 167 on Subscriber Service Card

Thermistor Psychrometer

A portable thermistor psychrometer, designed for immediate determination of relative humidity within 0.5%, has been developed by Atkins Technical, Inc.

In the device a rechargeable mercury battery powers a fan that circulates air about two thermistor beads that provide sequential wet and dry air tem-



perature readings on a direct reading dial within 10 secs. Operating temperature range is 7° to 192°F. Four scale ranges are provided with 0.1°F readability. Instrument accuracy is ±0.5° with sensors matched to 0.1°F.

Circle No. 168 on Subscriber Service Card

contracts and procurements

AWARDS

AIR FORCE

$2,421,000—**Ford Motor Co.,** Philco Corp., Palo Alto, Calif., for work on AF satellite control network.

$1,189,000—**McDoooell Aircraft Corp.,** St. Louis, to study spacecraft for the *Genini Manned Orbiting Labaratory.*

$1,200,000—**Geoeral Precisioo, Inc.,** Aerospace Group, New York City, for production of APN-102 Doppler radar navigation systems and automatic test equipment.

$723,381—**Johoson Service Co.,** Milwaukee, Wis., for *Atlas F* and *Titan II* SAC antenna modifications at Schilling, Lincoln, Altus, Dyess, Walker, Plattsburg, Vandenberg, Davis-Monthan, McConnell and Little Rock Air Force Bases.

$339,776—**ITT Corp.,** ITT Kellogg Communications Systems Div., Chicago, for missile technical operations communications system.

$215,000—**Electro-Optical Systems, Ioc.,** Pasadena, Calif., for the design and fabrication of a matched laser oscillator amplifier combination.

$151,059—**Hughes Aircraft Co.,** Hughes Research Labs Div., Malibu, Calif., for research directed toward the study of ionic and neutral species in thermal plasmas.

$146,813—**Western Electric Co., Inc.,** New York City, for communication equipment.

$134,052—**Geophysics Corp. of America,** Physics Research Div., Bedford, Mass., for design and fabrication of IQSY payloads.

$122,260—**Northrop Corp.,** Nortronics Div., Needham Heights, Mass., to fabricate and install a solar radio observatory.

$98,259—**Device Development Corp.,** Waltham, Mass., for applied research involviog payload designs, development and associated field operations involving upper atmosphere chemical release experiments.

$74,850—**Raytheoo Co.,** Norwood, Mass., for a duplex microwave system.

$49,233—**Itek Corp.,** Vidya Div., Palo Alto, Calif., for the design, construction and testing of a special nine-lens multiband camera.

$30,000—**Aerospace Research, Inc.,** Boston, Mass., for tbe study of short-term variations of the phase and field strength of CW transmissions in the VLF range.

United Aircraft Corp., United Technology Center, Sunnyvale, Calif., for demonstration of a unique solid propellant which would enable a solid rocket to be throttled and repeatedly stopped and started (amount undisclosed).

ARMY

$2,369,550—**Collins Radio Co.,** Dallas, for a 120-station voice-operated intercom system for the Manned Spacecraft Operations and Checkout Bldg. at the Merritt Island Launch Area, Fla.

$808,227—**General Dynamics Corp.,** Pomona, Calif., for addition to FY '64 *Redeye* R&D program.

$393,920—**General Dynamics Corp.,** Pomona, Calif., for industrial product and production engineering services on *Redeye* weapon system.

$208,902—**Sperry Rand Corp.,** Salt Lake City, Utah, for *Sergeant* missile system.

$48,000—**Sprague Eogineering,** Teledyne Ioc., Gardeoa, Calif., to engineer, design and fabricate a hydraulic filter test console.

$44,200—**Purdue Univ.,** Jet Propulsion Center, Lafayette, Iod., for iovestigation of high acceleration on the interior ballistic of solid propellant rocket motors.

$34,458—**Hughes Aircraft Co.,** Fullerton, Calif., for *Nike-Hercules* radar feasibility study.

$26,012—**ITT Corp.,** ITT Cannoo Electric Inc., Phoenix, Ariz., for *Nike-Hercules* repair parts.

$22,976—**Space Electronics Corp.,** Ft. Worth, Tex., for test equipment for *Sergeant* missile system.

NAVY

$1,096,544—**North American Aviation, Ioc.,** El Segundo, Calif., to install motors in the *Sidewinder* air-to-air missile.

$1,000,000—**Hughes Aircraft Co.,** Culver City, Calif., to build a *Polaris* missile training simulator for instructing submarine crews of Great Britain's Royal Navy; to be installed in the Royal Naval Polaris School under construction at Faslane, Scotland.

$93,000—**Bissett Berman Corp.,** Santa Monica, Calif., to furnish three advanced oceanographic instrument systems.

$19,999—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for R&D on *Palaris A-3* missiles.

Lear Siegler, Inc., Santa Monica, Calif., to provide the Pacific Missile Range with eogineering and scieotific services under a contract modification exercising a one-year option that extends a current contract (amount undisclosed).

DEPARTMENT OF DEFENSE

$1,225,000—**Sun Electric Corp.,** Aero-Space Div., Chicago, for test stands to check out airborne hydraulic components and control panels for the *Minuteman* installations at Grand Forks, N.D.

NASA

$3,259,000—**Pennsalt Chemicals Corp.,** F. J. Stokes Co. Div., Philadelphia, to build two altitude chambers at Cape Kennedy, Fla.

$1,500,000—**Scientific Data Systems, Inc.,** Santa Monica, Calif., for 12 SDS Model DEE-3 digital events evaluators for use in performing automatic systems checkouts on *Saturn* booster rocket stages at the Marshall Space Flight Center, Huntsville, Ala.

$1,440,000—**Aero Spacelioes, Ioc.,** Van Nuys, Calif., for use of the "Pregnant Guppy" to transport space components by air.

$800,000—**The Bendix Corp.,** New York City, for preliminary design studies of possible payloads for the *Apallo* Logistic Support System (ALSS), a lunar payload.

$750,000—**Geoeral Motors Corp.,** AC Spark Plug Div., Milwaukee, Wis., for *Apollo* LEM guidance and navigation CDU system.

$492,209—**Aerojet-General Corp.,** Sacramento, Calif., for the fabrication of necessary hardware and performance studies to determine the rocket combustion dynamic behavior of the hydrogen-oxygen propellaot combinatioo at high chamber pressure.

$461,143—**Data Controls,** Danbury, Conn., for an integrated automatic checkout ground telemetry station.

$350,000—**Kollsman Instrument Corp.,** Syosset, N.Y., for Lunar Excursion Module optical subsystem of the *Apolla* guidance and navigation system.

$332,575—**Aeronca Mfg. Corp.,** Middletown, N.Y., for developmeot of improved beat sbielding.

$282,534—**United Aircraft Corp.,** United Technology Center Div., Sunnyvale, Calif., for technological development of throttling a hybrid propulsion system.

$264,880—**Spacelabs, Inc.,** Van Nuys, Calif., for biomedical monitoring instruments.

$250,000—**The Bendix Corp.,** Pioneer Central Div., Davenport, Iowa, for supercritical cryogenic storage vessel for possible use in the *Apollo* program.

$248,857—**Bell Aerospace Corp.,** Bell Aerosystems Co. Div., Buffalo, N.Y., for an Earth orbital scene simulator display generator.

$246,358—**Pioneer Parachute Co., Inc.,** Manchester, Conn., for development and qualification of the para-sail parachute for application as an Earth landing system for second-generation spacecraft.

$212,519—**TRW/Space Techoology Labs,** Redondo Beacb, Calif., for an orbital debris reentry bazards study.

$147,654—**Union Carbide Corp.,** Linde Div., Tonawaoda, N.Y., for superinsulation systems for cryogenic test tanks.

$143,380—**United Eogineers and Constructors, Inc.,** Jackson and Moreland Div., Boston, for equipment requirements study for proposed NASA Electronics Research Center.

$136,000—**General Dynamics Corp.,** Astronautics Div., San Diego, Calif., to devise faster means of processing cloud pictures transmitted by orbiting weather satellites.

$95,570—**TRW/Space Technology Labs,** Redondo Beach, Calif., for a study of tradeoffs related to direct injection from Earth into translunar orbit for *Apallo.*

Philips Electronic Instrumeots, Mount Vernon, N.Y., to supply an X-ray system for mass-inspection of *Saturn* space vehicle parts (amount undisclosed).

INDUSTRY

$1,600,000—**American Bosch Arma Corp.,** Garden City, N.Y., from Grumman Aircraft Engineering Corp., Bethpage, N.Y., for design and productioo of warning equipment to be used on *Apollo.* The system will monitor, among other things, functioning of cabin oxygen and pressure.

$800,000—**ITT Corp.,** Industrial Products Div., San Fernando, Calif., from Martin Marietta Corp., Orlando Div., Orlando, Fla., a follow-on order for additional exploding bridgewire ordnance initiator firing units for the U.S. Army's *Pershing* missile.

$773,000—**G. T. Schjeldahl Co.,** Northfield, Minn., from Fairchild Stratos Corp., Space Systems Div., Bladensburg, Md., for the fabrication of 672 thin-film meteoroid detectors.

$250,000—**Computer Scieoces Corp.,** El Segundo, Calif., from California Institute of Technology, Jet Propulsion Lab., Pasadena, Calif., for computer programming services.

Electronic Engineering Co., Santa Ana, Calif., from Smithsonian Astrophysical Observatory, Cambridge, Mass., for precision electronic camera synchronization equipment for use in satellite tracking stations.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

U.S. Army Missile Command
Attn: AMSMI-IWB
Procurement and Production Directorate
Redstone Arsenal, Ala. 35809

Negotiations will be conducted with General Electric Co., Missile and Space Div., Valley Forge, Pa., for the design, fabrication and check-out of an extended dynamic range image orthicon television system. For information ooly; RFP not available. It is suggested that small business firms or others interested in subcontracting opportunities make direct contact with GE.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Negotiations are being conducted with Exotech, Inc., Alexandria, Va., for a research study of a velocity augmentation system and development of a prototype infrared penetration detector. For information only; RFP not available.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Study to investigate the feasibility of designing, constructing, and operating a large astronomical telescope in conjunction with a manned orbiting laboratory. Telephone requests should be directed to Hampton, Va., AC 703-722-7961/4784. RFP L-4568; due date 8/24/64.

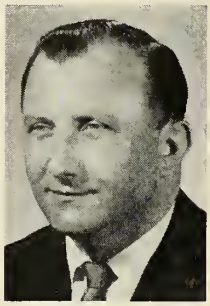
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md. 20771

Construction of magnetic quiet building and magnetometer shelter buildings at Goddard Space Flight Center. Job—IFB SC-1882; bid opening 8/6/64. Distribution of plans and specs limited to prime or general contractors only aod shall not exceed three sets each until supply is exhausted.

names in the news



CHOPE



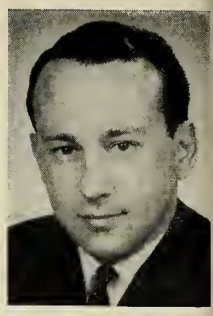
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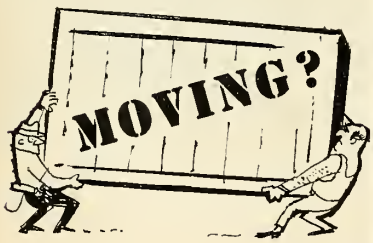


CONTI

William F. Riordan: Named executive vice president of the Rantec Corp., Calabasas, Calif. He is also manager of Rantec's Spectral Technology and Applied Research Div. in Santa Barbara, Calif.

W. E. Chope: Named winner of the Distinguished Achievement Award of Pi Kappa Alpha Fraternity in recognition of "his contribution to industrial progress as founder and chief executive of Industrial Nucleonics Corporation." He is presently president of that corporation in Columbus, Ohio.

Jaromir Kosar: Named general chairman of the Society of Photographic Scientists and Engineers' 1964 annual symposium.



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Missiles and Rockets
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Washington, D.C. 20005

Hugh Conway: Will join the Board of Bristol Siddeley Engines Ltd., London and will become managing director of the company succeeding the late Dr. E. J. Warlow-Davies Oct. 1.

Irving Schaffer: Appointed product manager for the ACCO Gyro Div. of American Chain & Cable Co., Inc., Waterbury, Conn. He will be responsible for engineering and production of the advanced performance gyros, accelerometers and inertial equipment made by ACCO Gyro.

Maynard M. Kepler, Jr.: Joined Computer Measurements Co., Los Angeles, as a senior electronics design engineer. He will be working primarily on all-silicon transistor counters.

R. E. Conti: Appointed assistant to the president of Data-Control Systems, Inc., Danbury, Conn.

William E. Cole, III: Joined Planning Research Corp., Washington, D.C., as a senior associate in the firm's Information Systems Div.

Edward A. Perry and **William C. Strang,** both specialists in space vehicle landing systems: Joined the Ventura Div. of Northrop Corp., Beverly Hills, Calif. Perry was formerly associated with the *Apollo* program at North American Aviation; Strang was previously West Coast representative for the All American Engineering Co. of Wilmington, Del.

Herbert Ellern: Appointed divisional vice president and staff scientist of the Industrial and Government Products Group of Universal Match Corp.

Chester D. May: Elected treasurer and corporate controller of Glass-Tite Industries, Inc., Meadville, Pa.

Roy A. Juusola: Appointed chief executive officer of Electronic Metals and Alloys, Inc., Attleboro, Mass. He will be responsible for the overall supervision of the company's operation.

Frank J. Meninger: Elected chairman of the Board of Directors of the Northern New Jersey Chapter of the Society for the Advancement of Management.

Sidney Allinikov: Named winner of the 1963 Cleary Award for outstanding achievement in materials research. He is an engineer in the Air Force Materials Laboratory, Wright-Patterson AFB, Dayton, Ohio.

Theodore H. Bonn: Has joined Honeywell, Inc.'s electronic data processing div. as a special assistant for research and development, a new position. He was formerly chief engineer of research and peripheral development at the Univac Div. of Sperry Rand Corp. Honeywell is in Minneapolis, Minn.

Milton Bryce: Appointed manager of systems programming information processing for the Univac Div. of Sperry Rand Corp., New York City.

Joseph H. Scrivner: Appointed group manager-reliability for Project *Gemini* at McDonnell Aircraft, St. Louis. He will be responsible for reliability engineering of the company's *Gemini* design and test activities.

Richard M. White: Appointed manager, White Sands Missile Range Office, *Athena* Program, Re-entry Feasibility Group, for the San Bernardino, Calif., operations of the Aerospace Corp.

Donald F. Lucey: Named executive vice president of SAAB Motors, Inc., and SAAB Overseas, Inc., New Haven, Conn.

Georges Fleury: Elected president of the Society of Industrial Chemistry. He is also president of the Society for the Study of Reaction Propulsion and the French Society of Astronomy.

William F. Radcliff: Named director of the engineering sciences subdivision of the Applied Mechanics Div. of Aerospace Corp., El Segundo, Calif.

William C. Hobbs: Elected to the post of senior vice president-advance program planning of Consolidated American Services, Inc. Also elected was Richard C. King to vice president-programs.

A. R. (Dick) Schott: Appointed vice president in charge of production at Bemco, Inc., Pacoima, Calif.

when and where

AUGUST

First Research Conference on Instrumentation Science, Instrument Society of America, William Smith College, Geneva, N.Y., Aug. 3-7.

Fifth International Symposium on the Reactivity of Solids, International Union of Pure and Applied Chemistry and International Union of Pure and Applied Physics, Munich, Germany, Aug. 4-10.

Performance of Government Contracts Conference, sponsored by Federal Publications Inc., and the Government Contracts Management Assn., Plaza Hotel, New York City, Aug. 6-7.

12th Annual Engineering Management Conference, Institute of Electrical and Electronics Engineers, ASME, AIIE, and ISA, Pick-Carter Hotel, Cleveland, Aug. 9-11.

Seventh National Heat Transfer Conference, American Institute of Chemical Engineers and American Society of Mechanical Engineers, Sheraton-Cleveland Hotel, Cleveland, Aug. 9-12.

Contracts Seminar, Department of Defense and the National Association of Professional Contract Administrators, Orlando, Fla., Aug. 10-13.

Structural Developments in Inorganic Chemistry and their Chemical Implications, AFOSR, New Hampton, N.H., Aug. 10-14.

"Digital Simulation" A five-day course sponsored by Control Technology, Inc., Long Beach, Calif., Aug. 10-14.

Thirteenth Annual Conference of Applications of X-Ray Analysis, Metallurgy Div. of Denver Research Institute at the Univ. of Denver, Albany Hotel, Denver, Aug. 12-14.

1964 Cryogenic Engineering Conference, University of Pennsylvania, Philadelphia, Aug. 12-14.

Elementary Nuclear Magnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 17-19.

Tenth International Symposium on Combustion, Combusion Institute and Cambridge Physical Chemistry Dept., Cambridge Univ., Cambridge, England, Aug. 17-21.

International Astronomical Union Symposium No. 25, AFOSR, International Astronomical Union, Government of Greece, and Univ. of Thessaloniki, Thessaloniki, Greece, Aug. 17-22.

Ninth Annual Showing of Advanced Electronic Research Projects, sponsored by Stanford Electronics Laboratories, Stanford Univ., Stanford, Calif., Aug. 18-21.

Elementary Electron Paramagnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 19-21.

Conference on Interference and Coherence, International Commission for Optics and Australian Academy of Sciences, Sydney, Australia, Aug. 24-25.

Nineteenth National Conference sponsored by Association for Computing Machinery, Sheraton Hotel, Philadelphia, Aug. 25-27.

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, Aug. 24-26.

Fourth Congress of the International Council of the Aeronautical Sciences, International Council of the Aeronautical Sciences and AIAA, Paris, Aug. 24-28.

Ninth Annual Technical Symposium, Society of Photo-optical Instrumentation Engineers and USAF Eastern Test Range, Deauville Hotel, Miami Beach, Fla., Aug. 24-28.

"Graphic Techniques for Computation," sponsored by the Univ. of California Extension Center, San Francisco, Aug. 24-Sept. 4.

"Nuclear Education in the New Era of Nuclear Power," sponsored by Oak Ridge National Laboratory, Oak Ridge Institute of Nuclear Studies, and U.S. Atomic Energy Commission, Div. of Nuclear Education and Training, Gatlinburg, Tenn., Aug. 24-25.

Western Electronic Show and IEEE Summer General Meeting, Biltmore Hotel, Los Angeles, Aug. 25-28.

1964 International Congress for Logic, Methodology and Philosophy of Science, and International Colloquium on Algebraic Linguistics and Automata Theory, sponsored by AFOSR, AFCRL, ONR, ARO, and International Union for History and Philosophy of Science, Hebrew Univ., Jerusalem, Israel, Aug. 25-Sept. 2.

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Alice in McNamaraland

AN INDUSTRY OFFICIAL commented recently: "Defense Secretary McNamara was a good man in his time and place. He has now outlived his usefulness. He can't project himself and DOD into the future. He has no vision. Unless there's a change, this country will be in trouble in a few years."

This is a harsh analysis of the Secretary of Defense, but not an uncommon one. Among McNamara's major contributions as DOD's chief executive have been his institution of program packaging, acknowledgement of industry's need for a better profit return, recognition of the benefits of competitive procurement and emphasis on cost reduction and its partner, cost effectiveness.

Whether one man can be expected to accomplish all this in the monolithic Pentagon and still be accountable for failure to project himself and DOD into the future is a question that implies Olympian standards.

But Mr. McNamara's truly remarkable record of accomplishment should not be allowed to obscure those areas in which he has demonstrated equally remarkable shortcomings. The industry official quoted above put his finger on one of them when he charged the Secretary with lack of vision.

Mr. McNamara has had his nose so close to the cost-reduction trees that he can't see the military forest. Waste can never be climinated from the Pentagon, because the whole place is a waste. All military organizations are waste. All military projects are waste. This is true because war itself is waste.

But waste or not, these military organizations and projects, and the industry which supports them are an absolute necessity and it is vital to the nation that they all be maintained in health and readiness. The military must be equipped to fight a war this week. Five years from today, and ten years from today, it must be equally ready to fight a war on instant notice.

If there is no war today, then the weapons for today's war must be thrown away and the weapons for the war five years away must be developed and procured. If war does not come in five years, then great numbers of those weapons must be thrown away in preparation for a war ten years from today. This is true because the enemy will not start a war with yesterday's weapons—he will have the most modern weapons available at the time of attack.

Yet Mr. McNamara's perhaps subconscious view of the industry which supplies these weapons is that of an unscrupulous giant feeding voraciously at the government trough. He was asked at a recent press conference about industry fears that the Defense Department was going to permit dangerous shrinkage of the industry and a loss of the mobilization base.

The Secretary's brisk rejoinder: "We don't propose to turn the defense industry into a WPA. We are going to buy what we need and only what we need."

Since there had been no suggestion that the industry was seeking WPA handouts, Mr. McNamara's tart comeback was totally uncalled for. Maintenance of an industry competent to produce the new weapons needed should indeed be a legitimate concern of the Defense Secretary. His answer suggests less than a full understanding of this fact.

We carry this week (p. 18) a most interesting case history of the progression under which Maxson Electronics Corp. replaced Martin Co.'s Orlando Div. as sole source on the *Bullpup* missile. Our New York bureau chief, Michael Getler, has unearthed the story in detail.

There is no question that some $40 million has been saved by the competitive procurement, and there is no question that Maxson fairly won the award with a lower price.

But some serious questions are raised by the award. The cost reductions were not solely attributable to second-sourcing. Martin-Orlando has had one of the most effective cost-reduction programs in the industry and has been officially recognized by DOD for this fact.

That recognition and a dime will buy them a newspaper with announcement of the Maxson contract in it. Martin officials can be excused if they are wondering somewhat bitterly today about Secretary McNamara's frequent promises that those firms which perform efficiently and satisfactorily will be rewarded. For the first time in the industry's history, the prime contractor and developer of a weapon system has watched all the production work go elsewhere while it has retained the pittance of a system management role on a missile it produced for six years on a continually declining cost curve.

If industry firms cannot count on production work to defray the high overhead which results from maintenance of a research and development capability, then this inevitably must drive up the cost of research and development. If the nation pays less for production of defense hardware, but more for its development, is there actually a net cost saving? It is this long-range effect which does not appear to be receiving full consideration in Mr. McNamara's cost-reduction drive.

WE WANT TO CALL ATTENTION also to the article on p. 10 by James Trainor concerning the remarkable muddle in antitank weapons development. We must echo the sentiment of Gen. Paul D. Adams that it is incredible that a nation which can send a probe to the Moon cannot develop a weapon which will wipe out the tank as a battlefield menace. Yet DOD has failed to do so.

In conclusion, consider this curious paragraph from a paper by the Institute for Defense Analyses, on which Mr. McNamara spends the taxpayer's money and presumably some of his time:

"Potential breakthroughs, as a result of military research and development, represent one of the most serious continuing obstacles to stability and still further disarmament."

A high Defense executive once remarked to us that three years is about the limit of any top DOD official's effectiveness. This is Mr. McNamara's fourth year.

William J. Coughlin

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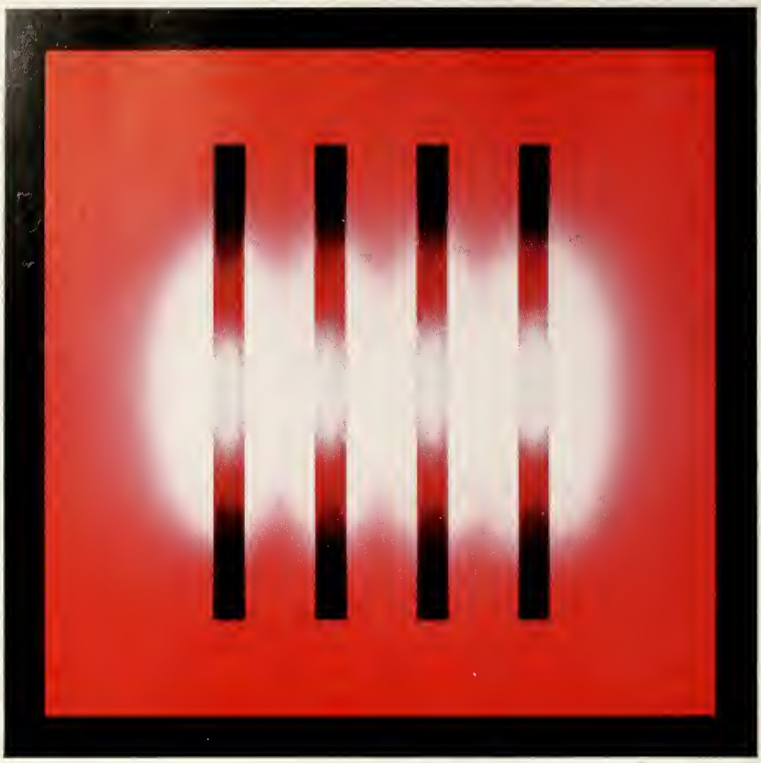
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AUGUST 10, 1964

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

AUG 19
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Guericke Crater (Upper Right) in Ranger VII Photo

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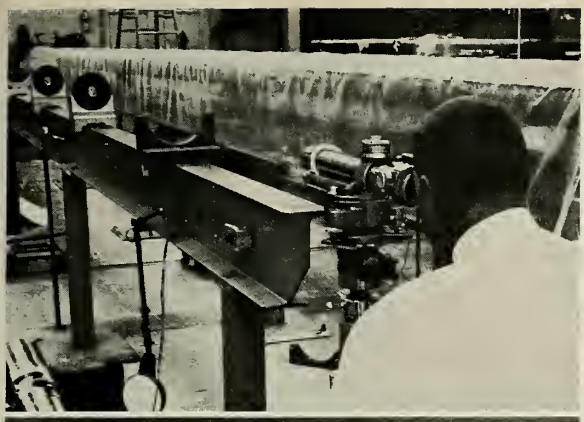


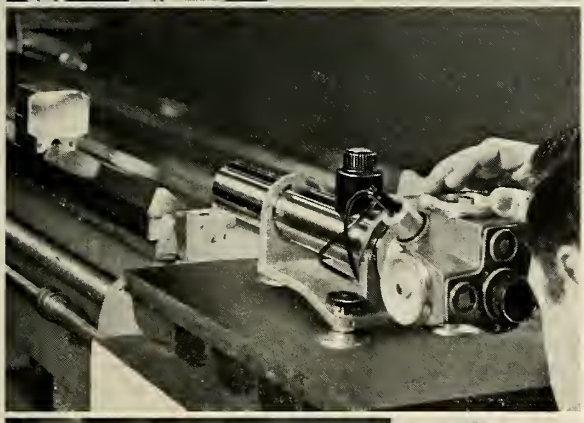
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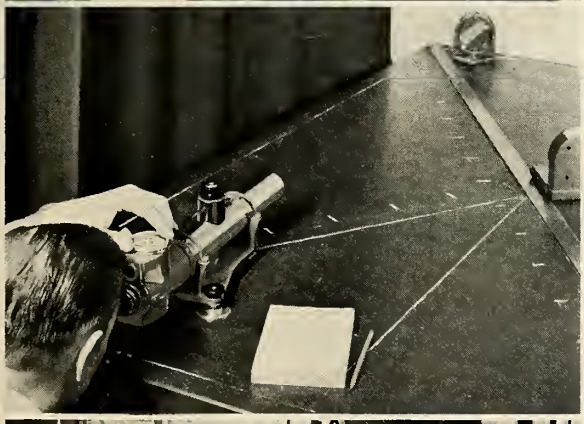
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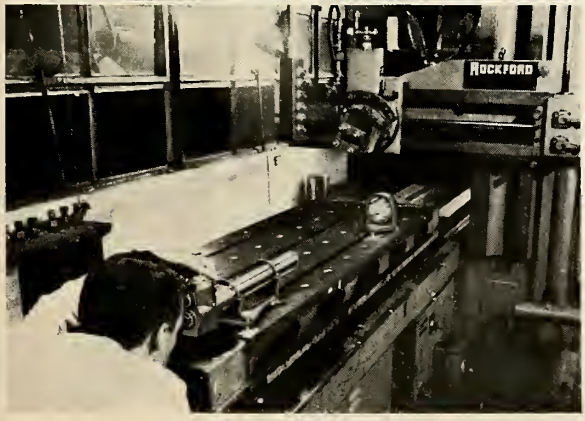
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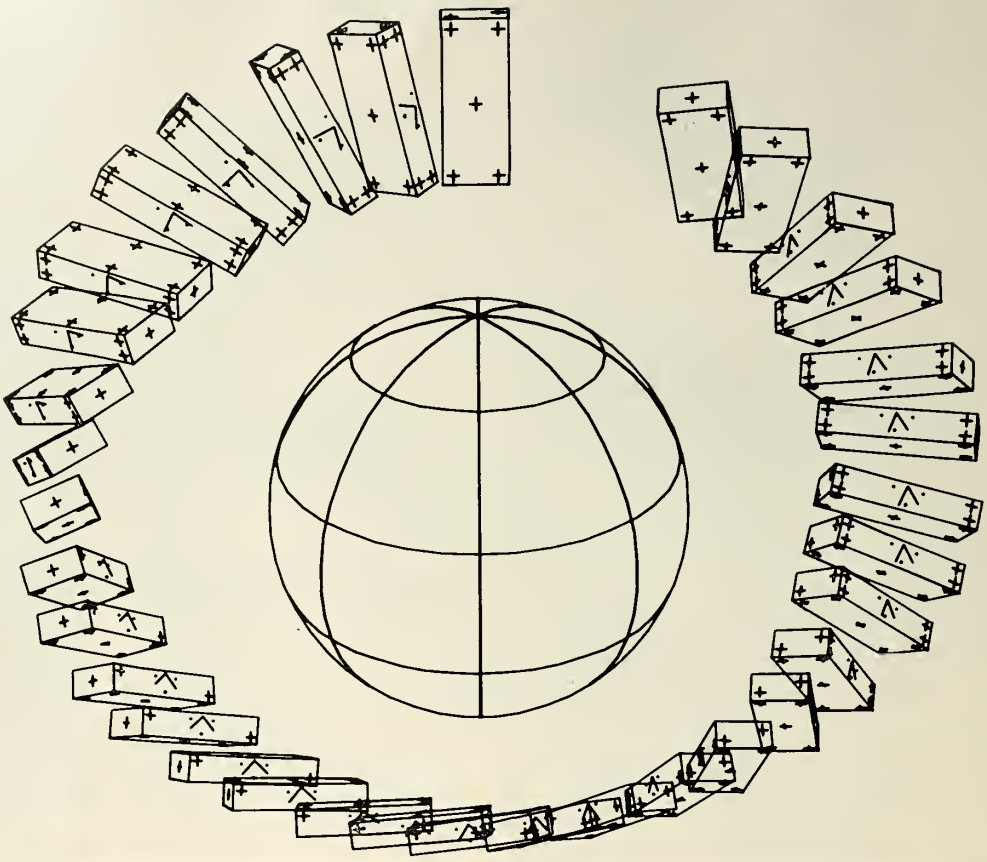
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 15, Number 6 August 10, 1964

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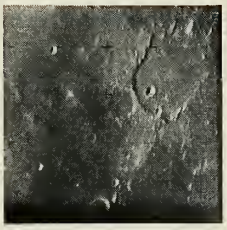
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THE COVER



Lunar surface photograph taken by Ranger VII F-b camera from 470-mi. altitude. Picture shows area about 6,084 sq. mi. Large crater at upper right is Guericke. Bigger of two conical craters on its floor is 4 mi. in diameter. The smaller craters shown are some 800 ft. in diameter. See p. 16.

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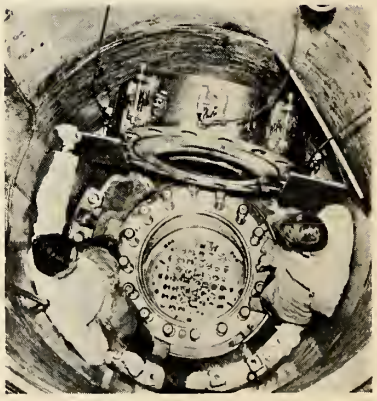
They soon graduated with highest honors from supersonic jets to lunar probes. Then came a challenge we weren't prepared for. Could they also withstand nuclear radiation?

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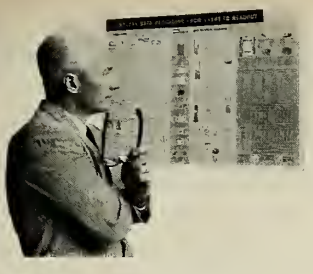


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To our knowledge, this is the most comprehensive chart of its kind in existence. Each instrument in the four categories shown below is covered — along with basic specifications, cross-reference tables to aid in selection of instrumentation, and information on how to use combinations of the various instruments to meet specific needs. We've even included detailed descriptions of the finest support equipment for dynamic measuring and recording in industrial and military applications.

Sensors and Pickups



Chart shows the 43 available for pressure, vibration, acceleration.

Signal Conditioners



Chart shows 11 basic types and where they may be required.



Magnetic Tape

Chart shows 8 analog and digital recorder/reproducers with support equipment.

Direct Readout



Chart shows 5 recording oscillographs, 33 galvanometers and where they can be used. Also support equipment.

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letters

Transportation in 'T Family'

To the Editor:

Your Eighth Annual World Missile/Space Encyclopedia (July 27) is a splendid issue. However, I believe you inadvertently transposed the identifying captions of *Terrier* and *Tartar* on page 110.

John D. Burnett
Brigham City, Utah

Reader Burnett is quite correct. The transposition will be corrected in reprints of the encyclopedia, available soon.—Ed.

Thought for Ranger VIII

To the Editor:

I have been reading accounts of the *Ranger VII* flight. May I suggest the launching of a projectile from *Ranger VIII* to the lunar surface during the final minutes of flight. TV pictures of such an impact on the Moon may provide additional information about dust cover and load-bearing properties of the lunar surface.

A. A. Wiese
Columbus, Ohio.

Beyond Ranger VII

To the Editor:

The gratifying accomplishment of *Ranger VII* merits the accelerated development of nuclear propulsion systems, composites for shielding components and systems from space-environmental and nuclear radiation, materials advantageously utilizing irradiation, and polycrystalline solids exhibiting permanent changes in gravitational characteristics following irradiation in outer space.

A low-density gaseous composite comprising low-elastic-modulus particles dispersed in a medium of higher elastic modulus than the particles (clouds of ionized particles in gaseous colloidal suspension) for protection from atomic explosions, was pioneered by me in 1945 and successfully tested by the U.S. Army in 1955. Solid forms of this basic concept, such as silicon carbide-carbonaceous composites in different densities, formable in layers by hot-compaction techniques, will function as radiation shields resistant to thermal shock and stress deformation. Thorium-doped layers adjacent to the uranium fuel rods in reactor chambers will absorb excess neutrons and function as breeder reactors. In some composites, the coating of some of the constituent particles with isotope solutions, such as those of boron, prior to compaction, will weld particles and thereby increase the strength of the composite in response to irradiation by slow neutrons.

Polycrystalline solids (metal alloys) of very great strength can be attained by incorporating therein long single-crystal microscopic filaments; when such metal alloys, doped with various isotopes, are subjected to weightlessness and irradiation in outer space, the atomic displacements resulting therein will cause permanent changes in the gravitational constants of the said metal alloys.

Some crystals increase in resistivity to the point of semi-conduction in an irradiated environment, and this phenomenon can be utilized advantageously in the designing of space components and systems.

Harry Bricker Fuchs
Farmingdale, L.I., N.Y.

Water-in-Space Problem

To the Editor:

The photos shown with the report, "Hercules-ABL Quench-Tests Antares Motors" (M/R, July 20, p. 13), are interesting, although the complexity of liquid tankage and plumbing encrustations on solid engines makes the storable liquid systems more advantageous for stop-start applications. Also, the high freezing point of water poses problems in space storability. Apparently the Hercules tests were not conducted in simulated space environment.

These points are relatively unimportant, however. The statement of yours which I wish to take exception to is "at space vacuum the water evaporates quickly, leaving the rocket ready for re-ignition." Tests conducted in Astrosystems' facilities under Contracts AF 04(611)-9084 and AF 04-(611)-9565 occasionally showed long-term residues of water ice after water injection remaining in contact with metal hardware (70-150°F) in simulated space environments. The reasons are (1) we are below the triple point of water (4.58 mm at 0.01°C) and (2) water ice has a relatively high heat of sublimation. Unless the water contains an additive (suspended carbon black) for high absorption of IR radiation, we cannot count on residual heat in nozzle parts to provide this heat of sublimation.

John S. Gordon
Manager, Physical Chemical Laboratory
Astrosystems International, Inc.
Fairfield, N.J.

Meaning of a Dollar

To the Editor:

Invariably your editorials have a message—sometimes a strong one.

Does DOD know the significance of the three-letter word ending in "x"? When Boeing, etc., earns a buck, first the U.S. takes 52¢, then state and local (governments) 20¢, leaving less than 30¢ for the company. They pay 10+ in dividends which are taxed 50%, or 5¢. If one could trace the remainder I venture to say most of it gets back to one or the other of the taxing authorities. So when the great economizer saves a dollar just what does it mean in terms of the U.S. government economy? Very, very little, I would say. A miserly small amount to equate against weakness against an enemy.

Barclay K. Read
McLean, Va.

BIG SHOT!

Lockheed Propulsion Company has successfully test-fired a massive 156-inch diameter solid rocket motor in a feasibility demonstration for the USAF Space Systems Division. This first firing of the world's largest solid propellant motor produced almost 1,000,000 pounds thrust. This fall, a second test firing will develop a thrust of 1,250,000 pounds. Still larger motor firings are planned. Basic objectives of this first test program were to static fire the large solid rocket motor with an ablative-throat nozzle; and to demonstrate the feasibility of a jet tab system of thrust vector control. Innovations included jet tabs in a large engine and use of 18% nickel maraging steel plate for the motor case. The success of the LPC test is a tribute to those who have long held that large solid propellant boosters are feasible.

PROPULSION ENGINEERS & TECHNICIANS: Programs such as this further strengthen Lockheed Propulsion's position in the ever-growing propulsion industry. LPC has immediate openings for qualified engineers and scientists in research, engineering, product assurance and operations. Write: Professional Employment Manager, Dept. 5208, P.O. Box 111, Redlands, California. An equal opportunity employer.

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The Countdown

WASHINGTON

Shillelagh May Be Used on New Tank

Shillelagh, Aeronutronic's anti-tank weapon, is under consideration for use on the joint U.S.-German Main Battle Tank. Army and Dept. of Defense officials are enthusiastic over operational evaluation tests of the General Sheridan-mounted weapon. In addition, short development cycle for the new tank may preclude development of an entirely new weapon system.

P-11 Satellite Is Detailed

Air Force is employing a small satellite carried piggyback on the aft skirt of the *Agena* spacecraft to sample the radiation belts. Designation is *P-11*. Once in orbit, the satellite is ejected from the spacecraft and a small rocket motor ignites to place it in an independent orbit. At least one launch of the *P-11* has taken place successfully. Satellite is part of the AF Environmental Sciences Program.

Penetration Test Set for Air Defense Net

A year-long test of the U.S. air-defense network is to involve elements of the Continental Air Defense Command, Army Air Defense Command, Air Force Air Defense Command and Strategic Air Command. Penetration of the electronic surveillance and missile coordination network will be simulated. Code name for the project: Operation Snow Time. Martin Co. has been named industrial support contractor.

Soviet Manned Space Attempt Expected

Intelligence sources here anticipate another Soviet manned space launch before the year is out. Probable objective: rendezvous. It is not believed Soviets yet have the capability for a circumlunar trip despite talk about it.

U.S. To Announce Russian Space Failures

Watch for a policy change shortly under which the U.S. will make public its knowledge of Russian space failures. One of the latest was the unannounced Venus probe. CIA has been against the policy change but will be overruled.

Checkout of Eglin Radar Is Under Way

The large phased-array radar at Eglin AFB, Fla., is expected to be operational within eight weeks. It now is undergoing checkout. The radar, 143 ft. high and 324 ft. long, will add significantly to Air Force space tracking and detection capability.

NASA Evaluating Fluorine Engine Bids

NASA is still evaluating eight bids on a 7,000-lb.-thrust liquid fluorine engine. But prospect for any development money in the Fiscal Year 1966 budget is dim. Funding is expected in FY '67.

Water-cooled Apollo Suit Is Favored

Manned Spacecraft Center, Houston, apparently has decided to go with the water-cooled space suit for later *Apollo* flights. Hamilton-Standard has a full-scale research and development program under way. Air-cooled suits were specified for *Mercury*, *Gemini* and early *Apollo* flights.

Nimbus Launch Is Due This Week

Nimbus weather satellite now is set for launch from the Western Test Range on August 14. The 750-lb. satellite will be boosted by a *Thrust-Augmented-Thor/Agena*.

Navy To Let ASW Contract

Navy plans to initiate a six-month study contract next month aimed at future anti-submarine warfare data collection and analysis systems. Interested firms have been invited to submit information this week regarding their qualifications. Award is expected about Sept. 17.

INDUSTRY

No Fizzle in Seven Up

Indicative of the pace of the revamped *Terrier* program is Atlantic Research Corp. firing of seven instrumented sustainer motors in one recent day of testing. Two additional firings were made at the firm's Pine Ridge, Va., facility the following morning to bring the total to 17 successive successful firings in recent weeks.

New Interest in Plastics for Bullpup

Industry sources say there is renewed service interest in the use of plastic fins for the *Bullpup* missile. Despite higher cost, it is believed these would cut substantially the interference in transmission of radio commands between pilot and the missile control system. *Bullpup* carries a fin-mounted antenna. Early versions of the missile employed plastic.

Apollo Gets Together

Full-scale mockups of Project *Apollo's* Lunar Excursion, Service and Command Modules, and the *Apollo* launch escape system, were brought together for the first time last week at North American's Space and Information Systems Division. NAA, which will provide the LEM adaptor section, will use the mockups to check interface requirements.

INTERNATIONAL

French Rocket To Use U.S. Unit

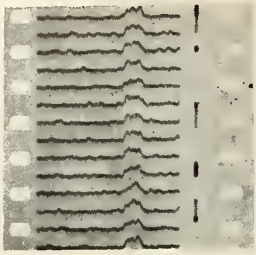
Attitude-control system for the French *Véronique* research rocket will be developed by Space-General Corp. The unit will be similar to one developed for NASA and flown on the *Aerobee* research rocket.

Japan Plans Satellite Launch

Japanese space plans call for launch of a 40-kilogram satellite prior to 1966. Team presently developing a new three-stage rocket, *Mu-III*, is headed by Professor Hideo Itokawa of Tokyo University. The new booster incorporates elements of the *Lambda* rocket.

Nord Plans New Target Missile

Nord Aviation has disclosed plans to develop a new French target missile, designated *C 30*. The firm now has sold some 150,000 missiles—including the *ENTAC*, *SS-series* and the *AS-20* and *AS-30*.



5000 POINTS PER SECOND

INFORMATION INTERNATIONAL, INC., Cambridge, Mass., has developed a completely automatic computer film reading system which can read film at the rate of approximately 5,000 points per second. Scientific data recorded on 16, 35 or 70 mm film can be read completely automatically and printed out in the form of numerical listings or recorded in digital form on magnetic tape for further processing and analysis. The film reading system is based on three major elements: A general purpose digital computer, together with a visual display scope; a Programmable Film Reader (PFR-1); and computer programs for using the computer and film reader.

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The Missile/Space Week

Information Centers Created

A system of information analysis centers to provide specific technical answers for managerial, scientific and engineering personnel has been authorized by Dr. Harold Brown, Director of Defense Research and Engineering.

Initially, the Dept. of Defense will establish 22 centers at a cost of $7.25 million. These will differ from DOD's present documentation centers, which are primarily concerned with handling of documents rather than the information contained in them. Another 11 centers may be created in the future.

The centers will be located at Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md.; General Electric Co., Santa Barbara, Calif.; University of Michigan, Ann Arbor (3 centers); National Oceanographic Data Center, Washington, D.C.; Office of Naval Research Branch Office, Chicago; Walter Reed Army Medical Center, Washington, D.C.; Tufts University, Medford, Mass.; IIT Research Institute, Chicago; Wright-Patterson AFB, Ohio; Battelle Memorial Institute, Columbus, Ohio (4 centers); Hughes Aircraft Co., Culver City, Calif.; Belfour Engineering Co., Suttons Bay, Mich.; Picatinny Arsenal, Dover, N.J.; Purdue University, Lafayette, Ind.; U.S. Naval Research Laboratory, Washington, D.C.; Watertown Arsenal, Watertown, Mass.; and Counterinsurgency Information Analysis Center, Washington, D.C.

LASV Fund Cut

Final disposition of funds for the *Low Altitude Supersonic Vehicle (LASV)*, which would have been propelled by the Pluto nuclear ramjet reactor, was decided as the House and Senate appropriations committee members met to settle differences in the appropriations bills.

The conferees agreed to accept the Senate version of the bill, which cut $6 million of the $12 million requested for *LASV* in the Air Force research, development, test and evaluation portion of the budget. Announcement of DOD's withdrawal from the program came after the House had voted to allow the funds.

This move brought the final Air Force RDT&E figure to $3.112 billion, and the Army's to $1.340 billion. A split in differences between the two bills on the Navy RDT&E budget brought that figure to $1.373 billion. This provided $2 million for Navy research, and $1.2 million for the Center for Naval Analyses.

Final figures in other areas were: Army procurement, $1.656 billion; Army operation and maintenance, $3.439 billion; Navy operation and maintenance, $3.144 billion; and Air Force operation and maintenance, $4.567 billion. The conferees also decided to allow the emergency fund of the Secretary of Defense $125 million, a compromise between the Senate $100 million and House $150 million.

ERC Deputy Named

Dr. Albert J. Kelley has been named deputy director of NASA's Boston Electronics Research Center.

Kelley, a Navy commander, is presently assigned to NASA as director of the Electronics and Control Div. of its Office of Advanced Research and Technology. He will assume the new responsibility on Sept. 1, the same day Dr. Winston E. Koch will take over as the center's director.

USSR Reveals New Booster

The USSR has announced plans to test "new variants of carrier rockets for space objects" beginning last week and continuing until the end of the year.

Russia has warned commercial shipping to steer clear of the 65-mi.-dia. impact area in the Central Pacific Ocean.

A rocket with a range of this magnitude could serve as an effective ICBM.

NASA Lets RFP's on AROD

Six firms have received RFP's from NASA to develop a test model Airborne Range and Orbit Determination (AROD) system for use aboard *Saturn V* missions.

The system would provide onboard data for determining the position and velocity of the vehicle in flight. It was conceived and its continued development will be directed by Marshall engineers, who began the program during FY 1963.

Advantage offered by the AROD is that it would derive from on-board the space vehicle information on its velocity and position at any instant. It utilizes simple ground stations, rather than the costly installations required for completely ground-based systems. The information derived

can be used for navigation as well as to determine vehicle performance.

The test model will be subjected to aircraft flight tests to provide preliminary performance evaluation of the integrated system.

Firms invited to submit proposals are: Brown Engineering Co.; Lockheed Missiles & Space Co.; Motorola Military Electronics Div.; Radio Corp. of America Communications Systems Div.; Sperry-Microwave Electronics Co.; and TRW-Space Technology Laboratories.

A single contractor will be selected with full responsibility for development of the test model. Proposals are due Aug. 31.

Shots of the Week

The Soviet Union on July 30 launched the 36th satellite in its *Cosmos* series. The Soviet news agency Tass reported that the scientific satellite attained orbit and was functioning satisfactorily.

- The Navy successfully fired two 2,800-mi.-range *Polaris A-3* missiles July 29 from the submarine Daniel Webster while it was cruising submerged off the Florida coast.
- France announced Aug. 1 the successful launching of a *Dragon* rocket to an altitude of 275 mi. from a base in Iceland. The shot by the National Center of Space Research was fired in cooperation with Icelandic scientists and carried instruments to measure the energy and direction of travel of particles in the Van Allen radiation belt.
- The Navy Dept. has reported that two of the eight *Zuni* missiles fired from U.S. jet aircraft during the Aug. 2 skirmish between the USS Maddox and three North Vietnamese torpedo boats hit their targets. *Zuni* is an area saturation weapon not designed for a high degree of accuracy.
- A *Hawk* air defense missile intercepted an Army *Roadrunner* missile in development tests at White Sands Missile Range July 30. The test was considered a success for both the target missile and the *Hawk* missile system.

AF Plans 50 More ICBM's

The Air Force has announced plans to install an additional 50 *Minuteman* missiles at Malmstrom AFB, Mont., bringing the total number of *Minutemen* there to 200.

Money for constructing the additional underground launch sites required is requested in the military construction bill now pending in Congress.

The Air Force currently has 600 of the "instant ICBM's" on operational status at four bases in the U.S.



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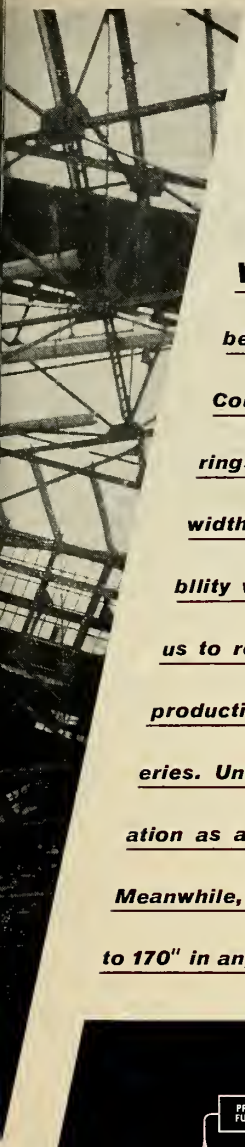
Up goes a new roof for Standard's ultra modern ring mill. Photo, taken in June, shows new 3,000-ton press and height addition to the building.



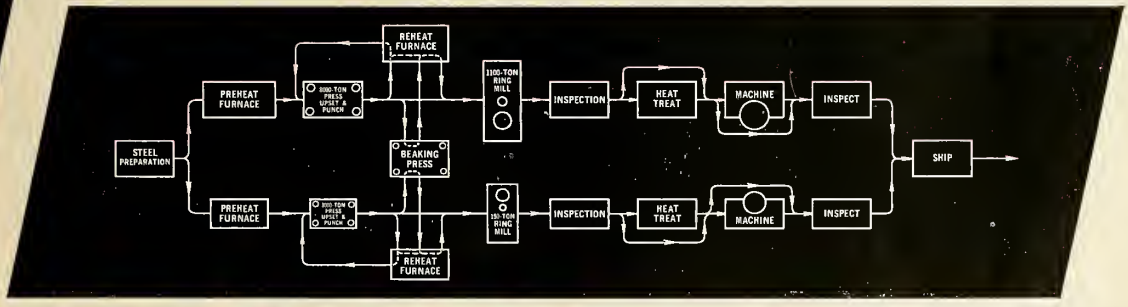
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DOD official says . . .

USSR Can't Salvo ICBM's

Main missile force believed to be unhardened, liquid-fueled, and dependent on unsophisticated command & control systems

by James Trainor

THE SOVIET UNION could not mount a salvo attack on the United States with the intercontinental ballistic missiles which it now has operational, a high Dept. of Defense official says. In fact, because of certain Soviet command and control arrangements, it is believed that a U.S. second strike could destroy a number of Soviet ICBM's before they got off the ground.

This official told MISSILES and ROCKETS that these facts have had a profound influence on the strategic force structure of the U.S. This is the reason the U.S. has procured ICBM's over and above those required simply to destroy Soviet cities.

"We have to have the forces necessary to blunt an attack," he said, "even after absorbing an initial strike."

He said Soviet ICBM's are similar to the early *Atlas* missiles in terms of vulnerability. They are soft, liquid-fueled vehicles stored above-ground, he said, and one indication of the vulnerability of this force is that "you don't even have to come very close" with a nuclear warhead to put them out of commission.

An equally important factor, he said, is the fact that the Russians have yet to demonstrate even the beginnings of U.S. solid rocket technology. This, he said, is of tremendous military significance and has been almost entirely ignored by the press in this country. He conceded that classification has made it difficult for the press to get the facts on this U.S. technological lead.

Overall, in terms of strategic retaliatory forces, DOD planners believe the U.S. has reached the point where "enough is enough." They cite Secretary of Defense Robert S. McNamara's budget statement to Congress that further quantitative increases in the large forces already programmed would provide only marginal increases in capability in relation to their costs.

Although the DOD official did not discuss what command and control arrangements precluded a mass attack on the U.S., it is understood that the Soviet ICBM force is deployed in complexes of perhaps six to eight missiles with a single launch control center. Since these missiles probably are radio-command-guided, the center can handle only one in the air at a time.

An article by *New York Times* military analyst Hanson Baldwin reported recently that the Soviets were developing a new, more accurate ICBM with a range of 6,000 miles. At best, however, this missile would parallel the U.S. *Titan I* or *Titan II*—large, liquid-propelled and possibly fired from the silo but more likely raised to the surface by elevator.

The Soviet lag in solid-propellant technology not only forces continued dependence on large liquid-propellant ICBM's, even in their hardened and dispersed sites; it appears that the same lag may severely hamper Russia's nuclear missile-firing submarine program.

The U.S. Navy considered and rejected the *Polaris* concept when the state-of-the-art would support only surface-ship liquid-propellant missiles. It was the development of solid propellants which made *Polaris* feasible. Assuming the use of less-hazardous, non-cryogenic propellants, liquid submarine-launched missiles would have to be either extremely large or of limited range and/or payload. Surface launch would also seem to be required.

● **Damage-limiting forces**—To minimize the destruction from a Soviet ICBM attack, the Defense Department has targeted a substantial portion of its *Minuteman* force on what it terms "time-urgent" targets. These include missile sites, bomber bases and submarine pens. *Minuteman* has been chosen for this role because of its multiple targeting capability, short reaction time (32 seconds) and short flight time.

The relatively low-yield weapon carried by *Minuteman,* however, means that the targets it is assigned to take under fire are soft or semi-hard military targets. *Atlas* and *Titan* are targeted on hard missile sites and other dug-in installations, such as command and control centers. These missiles carry much heavier, higher-yield weapons—*Titan II* warhead has been estimated at more than 10 megatons. The accuracy of these weapons is not as great as that of air-dropped weapons; therefore the B-52 force could take some of these targets under fire.

As the Soviet Union continues to harden and disperse its ICBM forces, however, a "damage-limiting" strategy becomes harder and harder to maintain. The number of weapons required to dig out a hardened missile site multiplies at the same time that the reaction time of the hardened missile becomes shorter. However, its value continues as long as the soft missile sites are maintained. The nuclear missile-firing submarines being built by the Soviets further reduce the efficacy of "damage-limiting."

● **Damage-assurance forces**—Equally important in the determination of force levels is the "assured destruction" of the Soviet target complex. Since "damage-limiting" strike forces are aimed at the reduction of destruction to the U.S., Defense officials must be positive that these missiles will destroy their targets. This involves an analysis of missile reliability, readiness, survivability and penetration. Detailed analyses of these four factors have led to the force structure which DOD has proposed.

Analyses which have postulated the most pessimistic situation possible—all B-52 alert forces caught on the ground and a larger percentage of missiles failing to reach their target than anyone really thinks likely—have been used to structure the strategic force package.

Touching only briefly on the question of missile reliability, this official readily admitted that missiles are not 100% reliable. However, he said, "this misses the point. We take into account the reliability of the missile in determining force levels and, if a missile is not as reliable as we would like, we simply buy more of them." ■

By quick voice vote . . .

Senate Approves $5.3 Billion for NASA

Amendments are easily defeated; full FY 1965 authorization approved, along with half of FY '64 supplemental request

by Heather M. David

THE SENATE easily passed by voice vote the Independent Offices Appropriations Bill including $5.3 billion for the National Aeronautics and Space Administration budget, after beating back several attempts to cut funds.

During debate last week much more one-sided than that which marked discussion on the NASA budget last year and earlier this year, the Senate voted against two separate amendments which would have cut funding by $100 million dollars.

Both amendments, offered by Sen. William Proxmire (D-Wis.), sought to cut NASA back to the level voted by the House Appropriations Committee. The Senate defeated one, 69-20, and the second by a voice vote.

Proxmire said that he "agreed with the 1970 Moon target date," and that his amendments were not based on any argument on whether the money should be used for research on Earth rather than space. He said that instead, the cut was just a careful, moderate reduction, and that "it is about time we provided some real cost discipline to NASA." He added that "everyone in this room knows of examples of waste by NASA."

Senators speaking for the bill pointed out that the Senate was not really allowing the entire authorization figure plus the supplemental, but only about half the supplemental—thus in effect cutting $68 million from the budget.

Therefore, they said, they should be allowed enough of a difference from the House figure so that a reasonable compromise could be worked out.

Proxmire was the author of an amendment last year which actually did bring the Senate bill back to the House level on the NASA appropriation. In that case, the disputed amount was $90 million.

● **Attitude different**—Proxmire got very little support on the Senate floor this year in his battle to cut NASA funds. In fact, almost all the senators who rose to speak had only praise of the space program.

Sen. J. William Fulbright (D-Ark.), who was known to have been honing up for a slash at the NASA budget for some time, had an apparent change of heart and barely appeared during the debate. His amendment would have sought to cut the *Apollo* program by 10%, or $267 million. Fulbright told M/R before the debate began that he had decided against offering the amendment "because of a change in climate." He indicated that both the success of the *Ranger* program and the current political situation worked to bring this about.

● **Boosters**—Echoing sentiments of the Senate Space Committee, the Appropriations Committee gave its views on the necessity for a national booster program. In its report to the Senate it said: "The committee is most encouraged to learn that NASA and some of its centers are seriously considering the use of space boosters which are being developed by the Department of Defense as part of the national space booster program. It is the view of the committee that this is the best and most economical use of our national assets."

The report also noted: "The committee wishes to encourage NASA to continue and improve their work on methods of recovery of the booster portions of the various types of space vehicles and feels that such efforts could lead to a great potential savings in the space program."

Committee sources said the group was pleased to note that NASA was considering possible uses of *Titan II* and *Titan III* and combinations of *Titan* and *Centaur*. Since the 1966 budget will include requests for studies and even development money for high-energy second stages for a number of boosters, the committee is anxious that the work be applied to the right systems.

The total of $5.3 billion provided in the bill includes the full amount of $5.227 billion authorized for FY 1965, plus $72,494,000 of the $141 million requested for supplemental funds for FY 1964.

In research and development, the bill provides $4,341,100,000, which is $109 million below the budget estimate. Full amount authorized for construction of facilities—$262,880,500, which is $18,119,500 below budget request—was granted. For administration operations, full authorization of $623,525,500, $17,474,500 less than the budget request, was voted. ■

Senate Committee Votes AEC $4 Million in LASV Costs

FINAL CONGRESSIONAL action on the Pluto nuclear ramjet reactor was taken as the Senate Appropriations Committee voted to allow the Atomic Energy Commission $4 million requested for costs arising from cancellation of the *Low-Altitude Supersonic Vehicle* (*LASV*) program by the Dept. of Defense.

The Senate committee said in its report that the money—plus the $1 million left in the original request by the House Appropriations Committee—would be used to meet additional close-out costs, "as well as funds to review the technology generated from the Pluto project in order to determine its application to other advancements in reactor technology."

"The committee agrees that this project, having generated intricate technology on high-temperature reactors from a combined expenditure of some $200 million by the Commission and the Air Force, should be so reviewed during 1965."

The Senate Appropriations Committee also voted to restore $2,435,000 which had been cut by the House committee. This brought the total AEC appropriation in the Senate to $2.268 billion, a figure $6,935,000 above that the House approved. It included these items: raw materials, $267,455,000; special nuclear materials, $398,500,000; weapons $765,000,000; reactor development, $496,435,000; physical research, $218,000,000; biology and medicine, $78,000,000; and other community items.

Ranger VII Proves Apollo Feasibility

Photo resolution, vastly exceeding expectations, indicates no changes are needed in LEM design; lunar dust no problem

THE SUCCESSFUL FLIGHT of the *Ranger VII* spacecraft—with a surprising picture-taking resolution 2,000 times greater than that of Earth-based telescopes—has given the U.S. the unquestioned lead in unmanned lunar and planetary space exploration.

The 4,316 pictures transmitted back to Earth have also confirmed the feasibility of the U.S. manned lunar-landing program.

Scientists report that a study of the photos revealed that the Moon would provide a suitable landing site and, therefore, design changes will not be required in the *Apollo* spacecraft's Lunar Excursion Module.

A preliminary analysis of the July 28-31 flight provided three other major conclusions:

—The lunar surface is covered by a very fine layer of dust which is perhaps only 1½ in. to 2 in. deep.

—The lunar surface is under continuous bombardment; as a result, the surface looks like crunchy snow or a material with the consistency of a biscuit.

—Crater ray areas—apparently formed by sprays from the creation of the large Marias or Seas—should be avoidcd as a landing site for manned space flight.

● **New scoreboard**—Dr. Edward C. Welsh, acting chairman of the National Aeronautics and Space Council, told MISSILES AND ROCKETS that *Ranger VII* was "the biggest boost in history for the U.S. space program."

He declared that the U.S. now leads the Soviet Union in successful escape missions to the Moon and planets and also has a slight lead in successful launches out of parking orbits around the Earth.

For the record, the U.S. has now chalked up two successful exploration flights to the Moon and Venus out of a total of 15 attempts. It should be noted that six of the unsuccessful flights came during the early *Pioneer* program, which featured small payloads launched toward the Moon on direct ballistic trajectories.

The Russians, on the other hand, have had one partially successful flight —*Lunik III*—which took photos of the back side of the Moon. Since that time, informed sources report, the Russians have an unenviable record of 17 to 21 straight failures in flights toward the Moon, Mars, and Venus.

The U.S. superiority—and resulting prestige—will increase sharply if the two Mars flyby missions with the *Mariner* spacecraft scheduled this fall achieve their goal.

Ranger VII was launched on July 28 at 9:25:48.8 am EDT. At 12:50:07 am EDT on July 31, following a 243,665-mi. trip from Earth, the spacecraft impacted on the Moon—only six to eight miles (plus or minus three miles) from the impact site planned during the mid-course guidance correction. The landing site was in the Sea of Clouds at 10.7 degrees S latitude and 20.7 degrees W longitude.

During almost 13 minutes prior to impact, its six TV cameras sent back to Earth the first spacecraft photos of the side of the Moon facing the Earth.

The event was hailed by President Lyndon B. Johnson as a tremendous technical achievement. "The success should spur us on to added effort in the future," he told Jet Propulsion Laboratory and NASA scientists.

● **Next on schedule**—The space agency already has laid plans to follow up *Ranger VII* with the launch of the two remaining spacecraft in the series. *Ranger VIII* is scheduled for January, 1965, but this launch date may be delayed if anything unusual turns up in the details of the lunar photos. *Ranger IX* will follow in about two months.

The *Surveyor* spacecraft flight program will be initiated in the last quarter of 1965; a total of seven flights is definitely authorized, and a total of 17 is planned.

Although the first *Surveyor* will be capable of soft-landing on the Moon and taking lunar photos, it is doubtful that actual picture-taking flights will be achieved until mid-1966.

Another spacecraft series—the *Lunar Orbiter Photocraft*—will begin its programmed 10 flights in 1966. The 800-lb. spacecraft will take pictures while orbiting the Moon, thus providing a wide-ranging survey of possible landing sites.

Ranger VII's camera system was composed of four narrow-angle cameras with a capability of taking a picture at intervals of 0.2 sec. Two wide-angle cameras had the capability of taking pictures at intervals of 2.56 sec.

● **Shea confident**—After a quick scan of the photos transmitted, Dr. Joseph Shea, *Apollo* spacecraft project director at the Manned Spacecraft Center, said that no changes would be required in the design of the Lunar Excursion Module landing pads.

"They won't have to be changed as a result of the *Ranger* pictures. They could handle a safe landing in the area shown in the last photograph taken by *Ranger*," Shea told M/R.

He added that landing requirements for *Apollo* probably would even be relaxed because of the knowledge gained from the photos. He said that one thing NASA was interested in was a study of the photos to find out whether there are rocks. "We think there may be some on the order of two feet across."

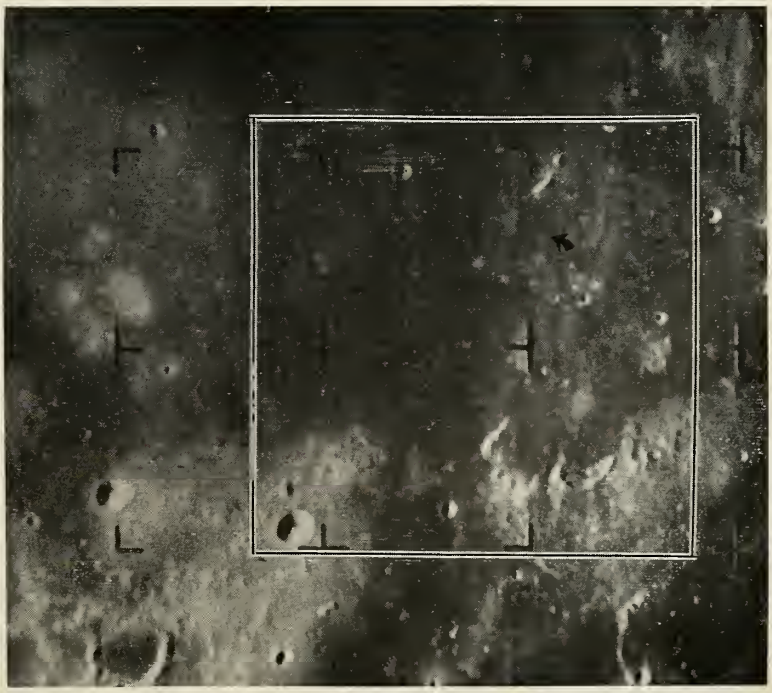
The last photo taken by *Ranger* will be used by the Manned Spacecraft Center to make contour maps. These will be contrasted with the LEM landing specifications.

Space agency officials said that it will take at least a month for the *Ranger* experimenters to complete the first detailed evaluation of the photos.

The first preliminary analysis was provided by Dr. Gerard Kuiper of the University of Arizona, chief evaluator of the photos. Kuiper said he believed the next *Ranger* flight should be aimed at the smoothest possible landing site.

(Continued on page 24)

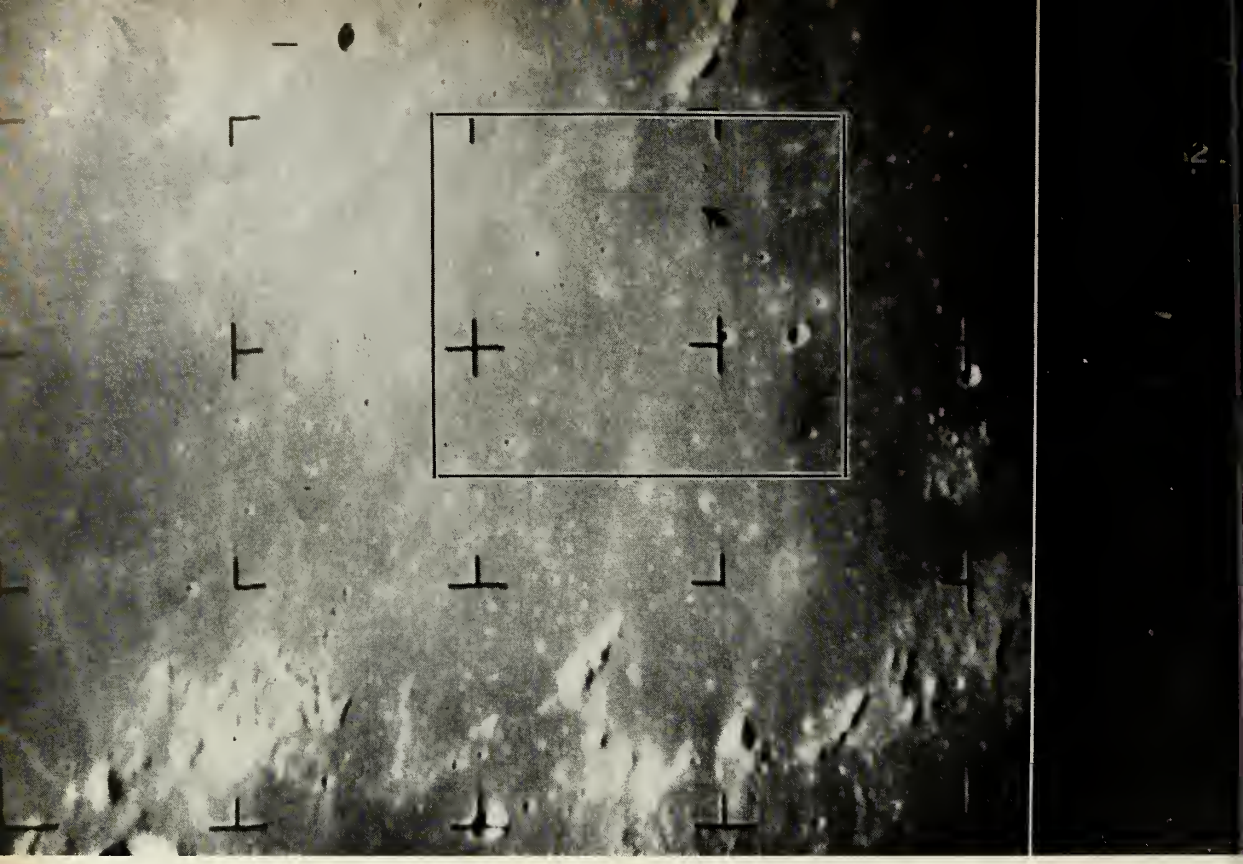
Ranger VII Photos



THE CLAIM OF SCIENTISTS that *Ranger VII* took lunar photographs 2,000 times better than any obtained from Earth-based telescopes is amply borne out on these pages.

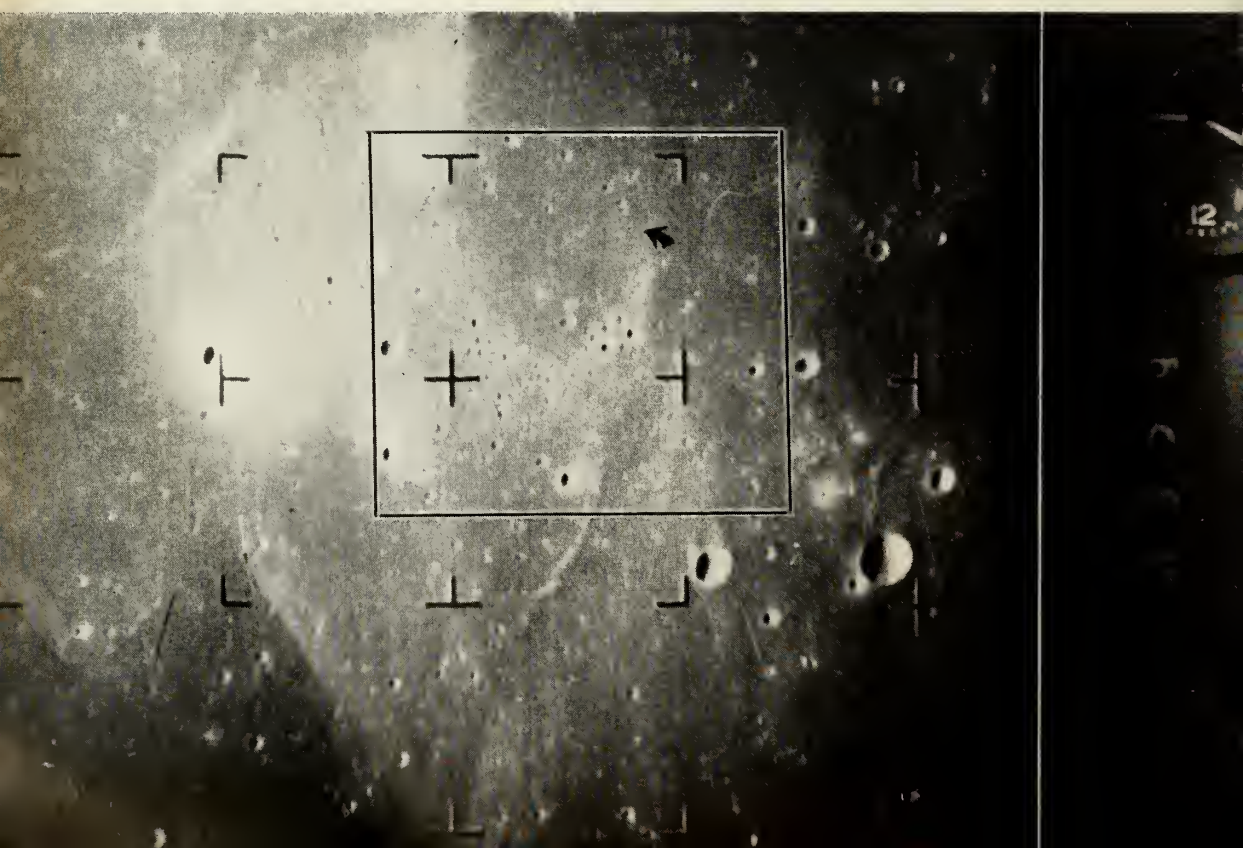
Until now, some of the best lunar pictures appeared in the *Rectified Lunar Atlas,* recently published by the University of Arizona Press. The amount of resolution in the *Lunar Atlas* picture (above) is almost equal to that seen in the two *Ranger* pictures taken when the spacecraft was about 470 mi. above the lunar surface, shown to the right and on the MISSILES AND ROCKETS cover.

In the picture taken from the *Lunar Atlas,* the right-hand rectangle indicates the area in the cover picture. The left-hand rectangle indicates the area covered by the *Ranger* picture (right). In each subsequent photo (pp. 18-22), a rectangle marks the area shown in the next full photo. The black arrows spot *Ranger VII's* impact point. All pictures have North at the top and, except for those on page 22, were taken by the F-a camera with a 25-mm, f/1 lens.



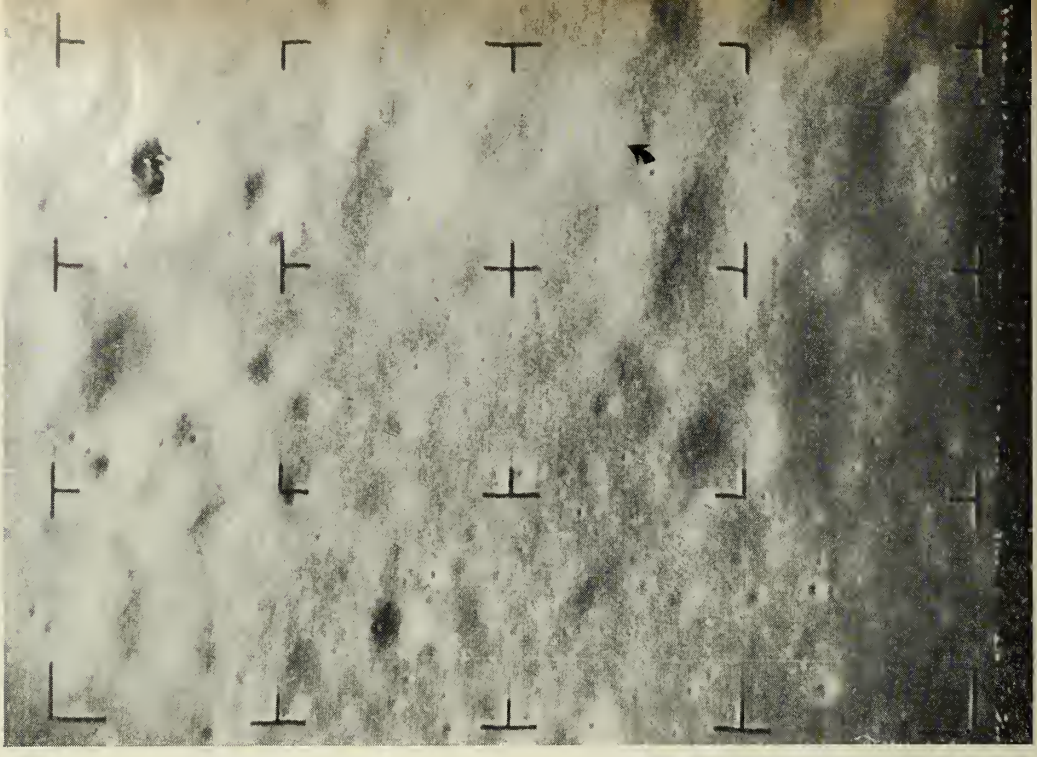
ABOVE: Taken at 235-mile altitude, picture shows area about 113 miles on a side, craters down to 1,000-ft.-diameter.

BELOW: Taken at 85 miles' altitude, photo shows an area about 48 miles on a side and craters down to 500-ft.-diameter.

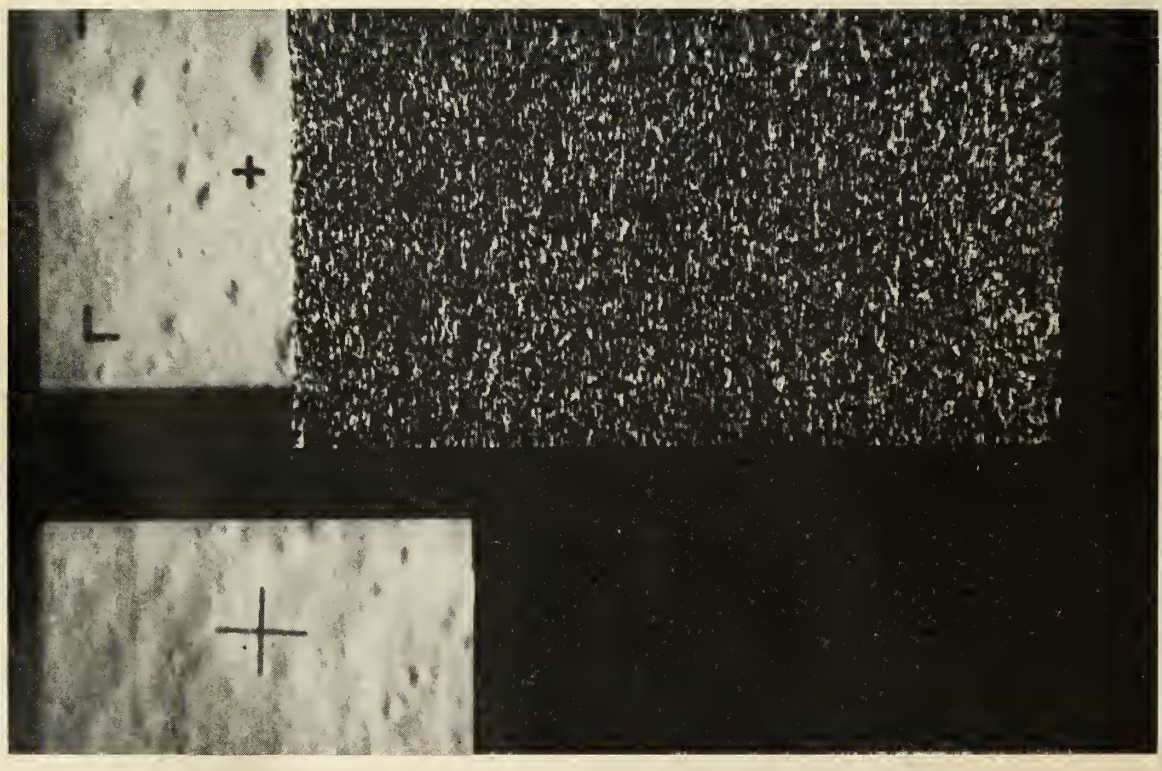


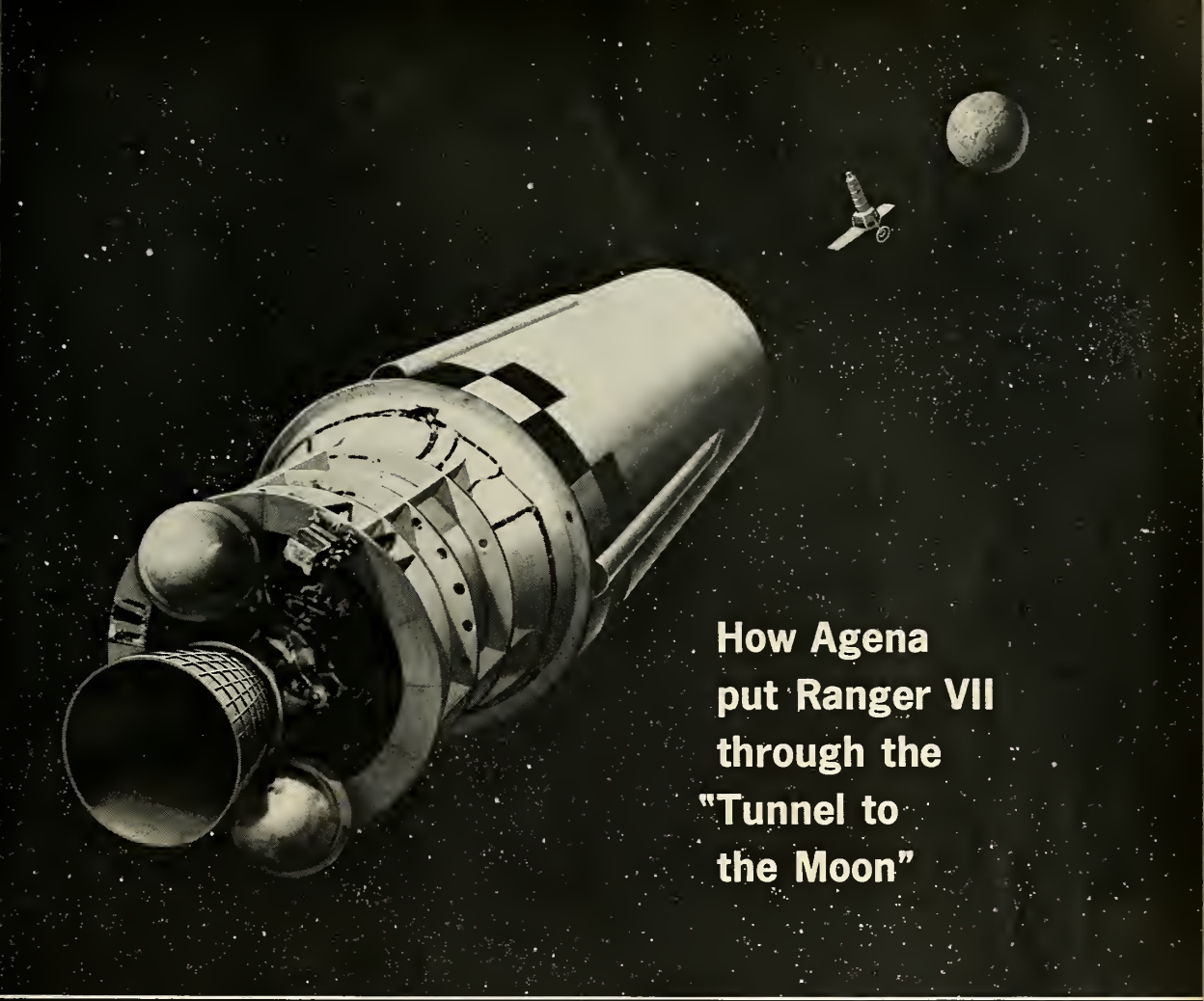
ABOVE: Taken at 34-mile altitude, picture shows an area about 16 miles square and craters as small as 45-ft.-diameter.

BELOW: View from 11 miles' altitude covers a region about four miles on each side and shows craters down to 15-ft.-diameter.

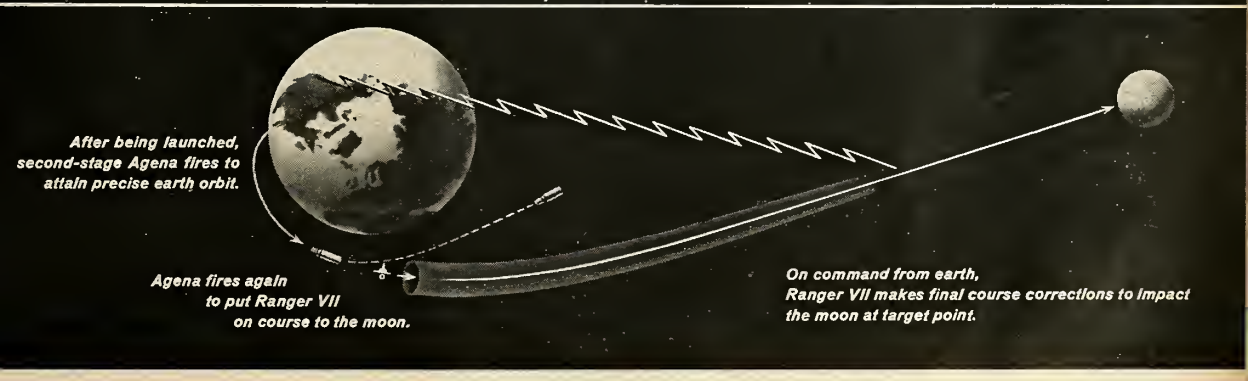


THESE TWO PICTURES, classed by NASA scientists as the "most significant" yet, were snapped during Ranger VII's final plummet. ABOVE: Taken at 3,000-ft. altitude by the P-1 partial scan camera with a 75-m, f/2 lens, picture shows an area of about 100 ft. on a side. Many of the craters have rounded shoulders in contrast with most of the larger lunar craters, indicating a relatively thin dust layer. BELOW: Taken at 1,000-ft. altitude, this was last picture shot by the P-3 camera, which has a 25-mm, f/1 lens. The spacecraft was destroyed while transmitting, resulting in receiver noise pattern seen at right. Picture covers an area of about 100 ft. by 60 ft., has resolution 2,000 times better than seen by Earth-based observations. Smallest craters are about 3ft. in diameter and 1 ft. deep.





How Agena put Ranger VII through the "Tunnel to the Moon"



First, the blast-off at 12:50 pm EDT July 28 — when Agena and its payload, Ranger VII, were rocketed into orbit 115 miles above the earth. Then Agena was commanded to execute the critical second phase: restart its engine, increase its speed to escape velocity (more than 24,000 mph), and score a bull's-eye on an imaginary, curving "tunnel," 10 miles in diameter and 75,000 miles long, representing the exact trajectory required for a successful moon shot.

Such precision is nothing new for Agena, the dependable space vehicle designed, developed, and built by Lockheed. In more than 130 launches to date for the National Aeronautics and Space Administration and the U.S. Air Force, Agena has proved its reliability—so much so that it has become a standard, production-line, second-stage booster and satellite specified for a variety of aerospace missions.

What's ahead for the Agena? More history-making flights—including rendezvous with NASA's two-man Gemini capsule. Here again, Agena's power and precision will help add another chapter to man's conquest of outer space. *Lockheed Missiles & Space Company, Sunnyvale, California: A Group Division of Lockheed Aircraft Corporation.*

LOCKHEED

Special Report

Success of Ranger VII

(*Continued from page 16*)

● **Other looks**—Kuiper and Dr. Eugene Shoemaker, another member of the photo-evaluation team, said targets of the remaining two *Rangers* would be the subject of very intense discussion. "It looked like the maria would be the place to land; now we'd be very interested in seeing other areas," Shoemaker said. "We need to go closer to the terminator to get a lower Sun and better shadows."

Kuiper said that the portion of Mare Nubium photographed was not a truly representative maria area. He said it revealed a remarkable clustering of very small secondary craters because it contained part of an outlying ray of the crater Copernicus located 400-500 mi. to the north.

Commenting on the "truly enormous" density of small impact craters shown in the first photos examined, Kuiper said the lunar section photographed contained "only small landing sites" for a manned vehicle and that such areas "should be avoided like poison."

"For the next *Ranger* shot, we should select an area entirely free of ray material in order to get a comparison," he told MISSILES AND ROCKETS. "I believe we'll find that other maria areas contain only one per cent coverage by craters."

● **Major findings**—The big news carried in the photographs, according to the experts' preliminary estimate, was that the Moon apparently offers no major landing difficulties—that if it does have a layer of dust or loose soil on the maria, that layer is only a foot or so deep over a hard surface.

But it was clear from reaction of some members of the photo-evaluation group that they had not expected sharp craters to exist down to such small size and in such great numbers on some lunar areas, including ray patterns. They were impressed by several things:

—The photos show that the crater ray patterns must contain many small secondary craters and are not merely dust streaks, Kuiper said. "These new results indicate the rays are caused not by small, fluffy material, but by material with sizable rock in it," he said. This contradicts a long-held theory that ray patterns are caused in large part by finely pulverized material, and means that landing in the vicinity of rays or along the extension of rays, where they have faded out, should be avoided.

—The rapid increase in number of small craters as *Ranger* drew ever closer to the lunar surface. These appeared in an area that had looked relatively smooth in photographs taken a few moments previously.

—One of the most significant conclusions drawn from the photographs was that the lunar surface showed a continuity of features "down to smaller and smaller sizes" as the cameras showed finer and finer detail, Kuiper related. Instead of smoothing out completely as some scientists had expected it might, that portion photographed continued to show new sharp pock marks. The final picture revealed small craters 3 ft. across and 1 ft. deep and having much the same form as the larger craters that are easily seen from Earth.

Preliminary conclusions drawn from the pictures pointed to the absence of thick layers of dust, according to spokesmen. Kuiper and Shoemaker, a scientist with U.S. Geological Survey, said sharpness of the small craters indicated lunar surface material was not like dust or sand and not very deep.

Such a surface covering would produce small waves with soft features on impact of a meteoroid, not the sharp craters that have now been observed. Shoemaker said the evidence indicated the surface is "littered by debris that is much thinner than I thought." He postulated a thin, porous layer over hard, dense material.

The University of Arizona scientist also said that although the photographs would bring "a tremendous range of new knowledge, they have not resulted in any totally unforeseen problems, and the origin theory is not immediately affected."

● **"Soft" craters abound**—One of the most puzzling new features noted by the photo-evaluation group was the large number of "soft" craters not previously revealed by Earth-based telescopes.

"They have a sort of worn appearance on the edges," Kuiper said. "These rounded features are new. Perhaps the roundness observed in some craters is more than erosion. Possibly we are dealing here with low-velocity impacts of less than 0.5 mi. per second." In comparison, meteoroids producing the primary craters arrive at 10-15 mi. per second.

In noting this, Shoemaker said he was surprised to see that as the magnification of the pictures increased, "even though the craters increased in number very rapidly, the pictures no longer looked as rough." He said he could not say whether this rounding and softening of features, including craters, was erosion or a new scale of phenomena.

"This is very significant," Shoemaker said, "but it is as yet perhaps too early to know what it means." He said that the size distribution of craters in the photographs would reveal a long record of the flux of small objects in space.

The soft appearance of the lunar surface began to be very noticeable in a photograph taken at an altitude of 11 mi. Larger craters in this picture lost sharpness, resembling finger impressions in soft dough.

This effect increased considerably in the next picture of the same area taken at a distance of three miles. But noticeable exceptions—small, sharp pinpoint craters—remained, indicating the softness of the other craters was not due to spacecraft motion or bad focus of the camera lens.

An unusual exception to the generally smooth appearance was a shallow crater about 300 ft. across that conatined an angular mass in its center. A preliminary conclusion was that the object in the crater was a fragment from Copernicus.

● **Culling out**—Kuiper said the 4,316 photographs obtained contained a large amount of duplication and that he believed they could be "combined into a much smaller number, perhaps 100 or more."

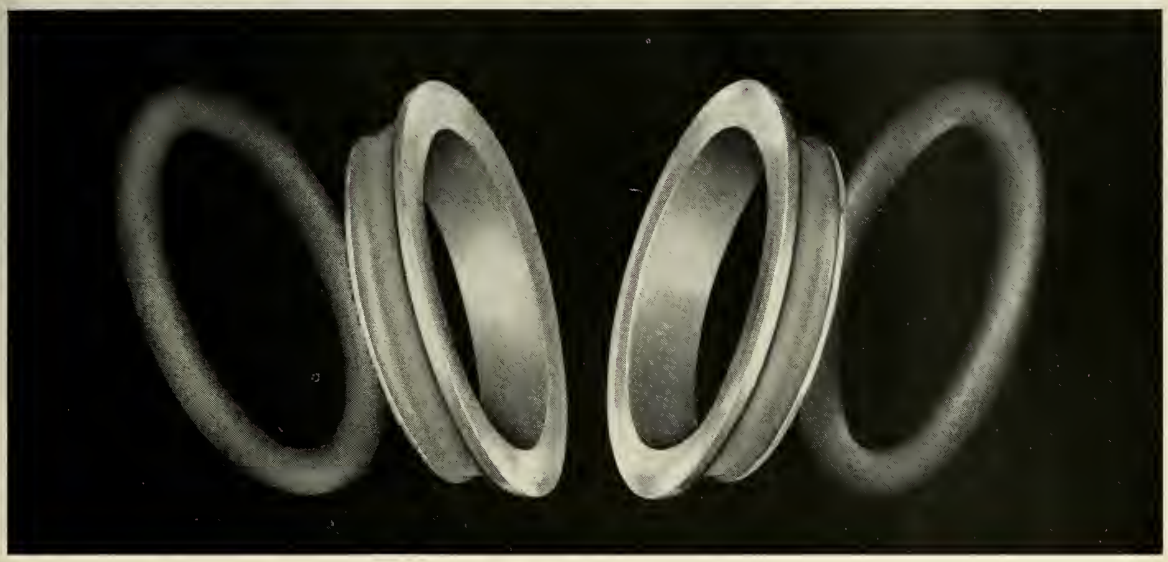
The immediate work to be done on the pictures is to take out the foreshortening effect due to the angle with which the six cameras viewed the lunar landscape as it descended. Superposition techniques will be used to take out other residual distortions.

Because the descent was not truly vertical, being about 12 degrees from straight down, successive pictures are taken from viewpoints with small horizontal separations and there is a very good possibility that stereo pictures will be obtained, which will considerably improve the extent to which the pictures can be interpreted.

Shoemaker is particularly interested in the use of this technique, since it is one that has been used with great success for interpreting aerial photographs of geological features on Earth.

The last picture taken about 120 milliseconds before impact was the best that could be expected and represents the limit the system scales to. Resolution of even smaller details than the 1.5-ft.-diameter craters detected by this shot may be possible by use of longer focal length lenses. However, the lenses being used have apertures of f/1 and f/2 and to try to carry longer focal length lenses with the same apertures would bring quite severe size and weight problems. "We are operating in terms of frame speeds and television parameters that we would not change," said Heacock, "Therefore, any change would have to be in the optical system." ■

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Daddario Unit Seeking Proper Level of R&D Aid

Permanent subcommittee hopes to come up with report this session; better management criteria another goal

Q *What is the next step in the work of your subcommittee on research and development?*

A We have come to the end of a series of hearings. We have heard from a large number of government officials, non-profit groups, university presidents and industry witnesses, and have accumulated a mass of information. There would seem to be no ready and easy answers, and there are numerous shades of differences in the testimony. There are many supporting statistics. It will be some time before the staff puts together a report and the committee can discuss it. We hope to come up with a report before the session ends.

Q *Do you see a need for legislation on the geographic distribution of research and development funds?*

A At the moment, we really can't say. We know that the allocation of research monies has a pronounced effect where funds are concentrated. But we are not sure as to the final effect over the course of time—we must look into that and we can determine better.

Q . . . *Indirect costs?*

A Here there could well be need for legislation. We are examining this to see if it will be necessary and if legislation is the best method to accomplish it. My own feeling, supported by testimony of government agencies, including the General Accounting Office and the Bureau of the Budget, is that the limit of 20% is arbitrary—that indirect costs can reasonably be determined; and since the government wants this work done anyway, it should normally pay the full cost. There is a difference, however, in areas in which the grantee has shown interest in pursuing a particular work. Here the government agrees to participate, and a cost-sharing arrangement results. However, this should be determined during negotiation. The real issue is over *forced* cost-sharing.

Q *Will your committee go into the problem of economic conversion of the defense industry in case of decreased defense spending?*

A Not directly, but by improving and extending our technological capabilities and interests, we will be better able to meet this problem when it comes. To date, our work indicates that if we are able to foster improved local activity and competence, and lift the potential of communities now in the doldrums, we will be better able to compete on the trade markets.

Q *What other work is the committee doing now?*

A The National Academy of Sciences is undertaking several studies for us through a 14-man committee headed by Dr. George Kistiakowsky, science adviser to former President Eisenhower. It will look into such questions as what is the level of basic research that should be supported Federally to maintain the nation's security, economy and industrial strength.

In addition, we have a Research Management Advisory Panel, which we believe will come up with meaningful criteria in the area of research management—not management of specific programs but policy determinations as they relate to technical competence and national goals—which ones ought to have priority, and how to manage them.

We are also arranging for special work in the field of science education. The National Bureau of Standards is developing a system whereby it may be of assistance to the committee. This agency has the capability of providing better purely technical information to us than we have been getting.

The objective is to establish better rapport as well as to get information. This applies to the entire executive branch, and to the academic community and industrial companies.

Q *Then you see your function as a permanent one in which you are a channel of communication between Congress and the scientific community?*

A Yes, we are a permanent subcommittee, although the House Science and Astronautics Committee has just begun to operate in this field. Because we have had the space program to look after, we have been mainly confined to it. But we do see the necessity for looking at all of the government-science relationship. The programs we're now setting up will help us better perform our jurisdictional responsibilities.

For instance, in the biomedical program, we have done a great deal of pulling and hauling to get the agencies to cooperate. As a result, DOD and NASA worked out a joint program, with a more efficient utilization of personnel and knowledge.

Q *Is there any chance you would ever recommend a central agency to administrate R&D?*

A The general feeling seems to be that each agency that has an R&D responsibility has its own best experience and competence to handle it. I have felt, for example, that there ought to be a wider latitude in the research done for the Department of Defense, since our most important goal is national security. It therefore may be more costly because of time and necessity. In other areas, control should be tighter. At the moment, I think our system is generally good, but it needs improvement. Our objective is to find ways of doing it better. ■



Rep. Emilio Q. Daddario (D-Conn.) heads a subcommittee of the House Science and Astronautics Committee which is delving deeply into the problems surrounding the massive government R&D investment—which in FY 1965 totals $15.287 billion, or 15.6% of the U.S. budget. Since the subcommittee was created last session, it has heard from virtually every top scientist and scientific manager in the country. M/R Congressional Editor Heather M. David interviewed Daddario recently for this progress report.



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Much of this USS Maraging Steel in large plates is being used in the Aerospace Industry feasibility studies for NASA and the Air Force. This program is designed to provide gigantic solid-propellent space-booster motors having a gross thrust of 4 to 12 million pounds. Motor sizes include 156″ and 260″ diameters with lengths of 60′ to 120′. Such huge motors present a real challenge to the fabricators but Maraging Steel simplifies the problems. It eliminates the need for huge heat-treating furnaces and the steel has excellent dimensional stability. Higher strength and greater toughness are welcome bonuses.

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yield strengths up to 340,000 psi



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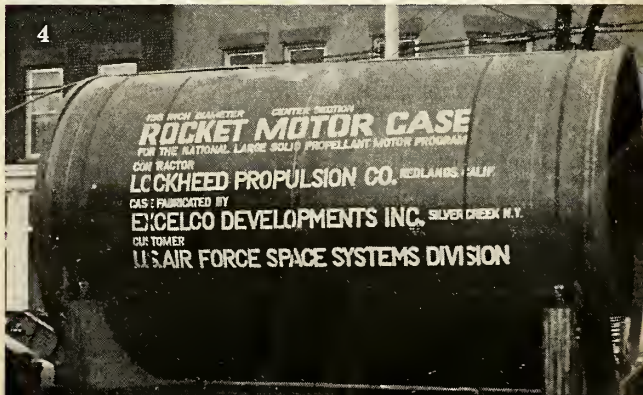


1. This ⅜" x 11' 6" x 41' USS Maraging Steel Plate was produced for the motor case of a rocket. A USS technician checks the soundness with an ultrasonic gage.

2. Fabricated component of USS Maraging Steel for a rocket motor case formed on a 2500-ton press.

3. Tooling setup at Excelco Developments, Inc., Silver Creek, N. Y., for fabrication of forward dome section of solid propellent rocket motor 156" in diameter.

4. Giant 100-ton center segment of million-pound-thrust rocket motor with case made of USS Maraging Steel being shipped from Lockheed Propulsion Company's Redlands plant to test base for static firing.



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or, we hope you appreciate what we go through just to get some of these stories.

On an average day at our Astromechanics Research Division, a writer is lucky to get directions to the water cooler. We know. We wrote last year's ad (exhibit A) featuring their fluid state Double Leg Elbow Amplifier. But that was nothing compared to getting this follow-up story about how the Amplifier has been applied to stabilizing airborne vehicle roll as part of a fluid state rate sensing and control system.

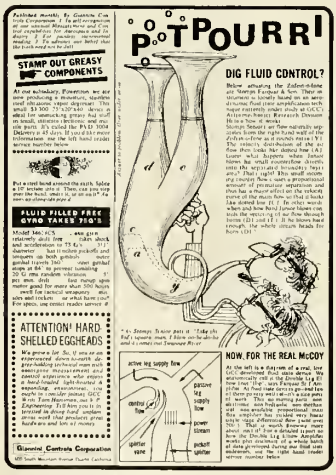


Exhibit A: Last year's ad.

FRONTAL ATTACK FAILS

To walk into Astromechanics' lobby with note pad and photographer is like parachuting-in behind enemy lines. Sirens wail. Doors slam. Tumblers click. The receptionist impales you with an accusing stare. And from there, it's an uphill battle all the way. Top Dog in this den of proprietary ball-hiders is Mel (The Clam) Zisfein (shown giving the photographer a hand in exhibit B). Under Mel is a mixed bag of scientific secret-mongers worthy of the CIA.

THE TRUTH PREVAILS

The preceding paragraphs should give you a heightened appreciation of the following categorical statement: *despite*



Exhibit B: System photo #1.

the evasionary tactics of Zisfein and his Merry Men, we can absolutely guarantee you that no matter what ANYBODY *says, our Astromechanics Division definitely has a working fluid state rate sensor which accurately measures vehicle roll rate. Furthermore, they have actual test data on it.* Your reporter spent 14 miserable hours in an overhead air conditioning duct just to verify these facts.

THE TOTAL SYSTEM

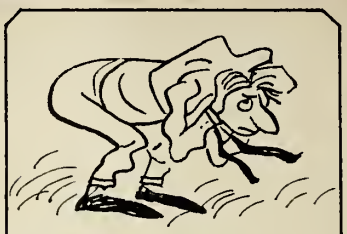
The idea behind the system within which the rate sensor works is to provide totally automatic flight control without resorting to electronics or moving parts. All control is accomplished by varying the volume and direction of a fluid flow. As a result, reliability increases by several orders of magnitude despite high levels of shock, vibration and radiation (the rate sensor portion of the system will also withstand a flying tackle, which is more than you can say for our photographer – see exhibit C).



Exhibit C: System photo #2.

THE BEST WE COULD DO

Exhibit D sort of diagrams how the roll stabilizing portion of the system works. We've altered a few contours and left



Attention: HI-SPEED, LOW LEVEL DRONE BUILDERS

The best way to keep track of drone aircraft altitude has to do with two very producible, very accurate, very low cost GCC absolute pressure transducers. One of these (#451318) keeps a running gauge of altitude at all levels. The other (#451212) gives excellent accuracies at altitudes under 500'. Both are being used in operational drones.

For more info:
Reader Service # 10.

out some pipes, ducts, etc. But if you're bothered by these gross inaccuracies, please bear in mind that our preliminary sketch was made in that air conditioning duct, on edible paper, using invisible ink.

RATE SENSING & AMPLIFICATIONS

For a fluid flow, Astromechanics uses gases from a slow-burning solid propellant. The gases flow to a supply main which branches to various parts of the

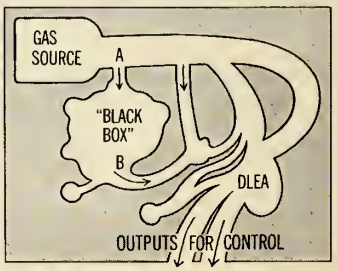


Exhibit D: Semi-accurate diagram.

total system. Flow (A) enters a frammis that Zisfein calls "just a black box" (but *we* know that's where the rate sensing is done, don't we?). The flow emerging from pipe (B) is, in effect, a variable control signal proportional to vehicle roll rate. This flow, suitably biased, is the control flow to the Double Leg Elbow Amplifier (DLEA) featured in exhibit A. This control flow, amplified by the DLEA, yields power flow outputs that are used to control the vehicle about its roll axis.

HOW ROLL CONTROL HAPPENS

If you used conventional techniques to provide roll control, you'd simply use the DLEA output to drive reaction jets. But at Astromechanics, they've got a much more effective method. If you'd like to know about *this* ramification, call Zisfein at (215) 644-1600 and tell him you've got development dollars to spend. Or, if you're developmentally broke, write to us for the one thing *we're* expert in: How to get into Astromechanics' overhead air conditioning ducts.

Technical Countdown

ELECTRONICS

Nuclear-Electrical Generator Studied

Direct conversion of radioisotope energy to electrical energy will be studied by the Columbus Laboratories of Battelle Memorial Institute for NASA's Lewis Research Center. Under the eight-month study contract, the labs will evaluate a Battelle-developed alpha-electric cell designed to produce an output in the 1-million-volt range. Inherent in the design is a method obviating the normal heat cycle needed by more conventional nuclear-electric generators. The system, says Battelle, operates without moving parts and employs a vacuum chamber. Using polonium-210, a proof-of-principle generator has produced up to 50,000 volts. The range will be extended to a megavolt under the new contract.

Time Reversal Study Upsets Physics Laws

Princeton University experiments have cast doubt on the physical laws of time-reversal invariance. Tests performed by the university at Brookhaven National Laboratory's particle accelerator indicate exceptions to what was previously considered a basic concept—that is, that other physical laws remain unchanged when time direction is reversed. A first report of the work, supported by the Office of Naval Research, appears in the July 27 issue of *Physical Review Letters*. In the Princeton experiments, some 50 examples of the "forbidden" two-pion decay mode of the neutrally charged k-2 meson were recorded. Such decay to a positively and negatively charged pi-meson is contrary to the Charge Conjugation—Parity rule. The so-called forbidden event, says Princeton, actually occurs at a rate of 1/500 decays.

Marshall Orders Laser Gyros

Sperry Rand's Electro-optics Group at Great Neck, N.Y., has received a $65,807 contract from NASA's Marshall Space Flight Center to develop and produce two miniaturized laser gyro systems (M/R, June 1, p. 29; Feb. 18, 1963, p. 28). Sperry says MSFC will evaluate the devices as a means to sense rotation rates of ground-based booster tracking systems. Each gyro will be housed in a package no larger than 15 in. square and 5 in. high. They will be mounted on the antenna gimbal structures to sense and measure angular rotation rate of the trackers. The gyros are required to sense angular rates between 0-5°/sec. with an accuracy of ±1 arc sec/sec. Delivery of both units is set for late this year, according to Sperry.

Amphenol-Borg Begins New QC Program

Amphenol-Borg Electronics Corp. has launched a new quality control and reliability program, aimed initially at high-reliability missile/space-type connectors, which company officials say is badly needed in the electrical connector field. The firm, which claims to have the largest single share (18-20%) of an estimated $300-million connector market, has begun identifying all production units of its three top missile/space lines with specific coding numbers that correspond to detailed information on production methods, materials, parts, and life data. In addition, in about six months the firm will begin putting "reliability numbers" on connectors that relate directly to specific test cycles to which that unit has been subjected. The firm will use at least three to four different test schemes in an attempt to get away from the traditional time-temperature method of defining connector reliability; adding shock, vibration, and altitude test data. In June, the firm reoriented its West Coast facility, now Space and Missile Systems, for production of aerospace devices.

Nuclear-burst Simulator Developed

The effects of high-altitude nuclear explosions may soon be studied under controlled conditions by means of a new $750,000 exploding-wire system developed by Field Emission Corp. Developed during the past two years for the Air Force Systems Command, AF Weapons Laboratory, the ultrafast pulsed power system discharges at a peak power of 2×10^{10} watts with a 50-nanosec. pulse. Temperatures up to 1,000,000°F are generated, the company claims. Through use of such simulations, the scientists expect to study a variety of nuclear-burst phenomena—such as light output, plasma generation, and shock waves—at a relatively low cost.

Instant Power Obtained from Cold Batteries

Silver-zinc batteries can be activated instantly from temperatures down to −65°F by the use of chemically-derived heat. The accessory heat exchange for the electrolyte was developed for the Army Electronics Command by Catalyst Research Corp. The company says activation occurs within 0.5 sec. at the lower limit and the result is normal voltage output and operating life under standard load. Voltage regulation is constant within ±5%.

SPACE MEDICINE

Med Tests Cheaper by the Dozen

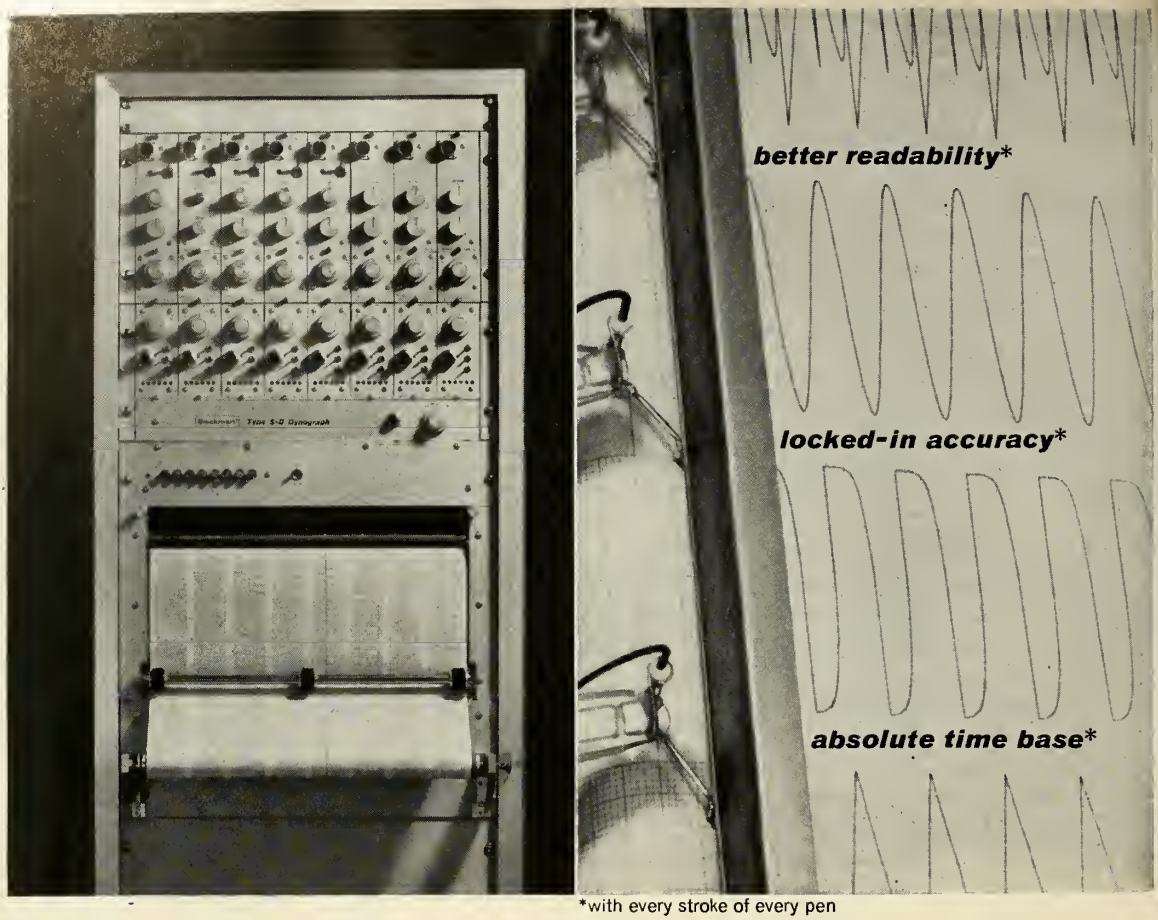
Forty-eight college men are participating in a three-year study for the Air Force Systems Command's Aerospace Medical Research Laboratories at Wright-Patterson AFB and the National Aeronautics and Space Administration. Divided into 12 groups of four, the men will serve in the project for a total of six weeks each—one week of indoctrination, two weeks as a control, two weeks in a pressure suit, and one week in post-experiment debriefing. They will be studied for nutritional requirements, hygiene, and other biomedical measurements during the period.

Metabolism Studies To Be Performed

Lockheed Aircraft Corp. is designing a new device to simulate man's metabolic processes. To be developed under a $93,000 contract for NASA's Manned Spacecraft Center, the equipment will closely simulate an astronaut's performance, and will be used to evaluate life-support and space-suit systems for manned spaceflight.

Radiation Studies Result in PHS Contract

One remarkable fallout of the space program is a promising study of potential anti-cancer chemicals by North American Aviation's Life Sciences Dept. Drs. Robery D. Shultz and David Norman have received a $198,185 contract from the Public Health Service as a result of a study performed for NASA on radiation effects on certain compounds in conjunction with space work.



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Douglas Developing Improved Delta

Increase in second stage diameter will allow propellant boost to place heavy payloads in polar orbit from Cape

by Willard E. Wilks

SANTA MONICA, CALIF.—Douglas Aircraft Co. has started work on an upgraded *Delta* launch vehicle that will be capable of placing heavy payloads in polar orbit from Cape Kennedy.

NASA is ordering eight of the "fat tank" *Deltas*, in which burn time will be more than doubled.

The *Improved Delta* will enable major mission improvements that include:

—Eastern Test Range polar capability for heavy payloads applicable to such spacecraft as *Biosatellite* and *Tiros* and *ISIS*-type weather satellites.

—Increased Earth-escape capability of 230 lbs. compared with 100 for the standard *Delta*, applicable to *Pioneer*- and *IMP*-type vehicles.

—Increased payload for low circular orbits for *Biosatellite*-type satellites.

The contract for development, fabrication, test and delivery is effective from June to January, 1966. Improvements are expected to cost about $6 million, bringing cost of the eight vehicles to about $15 million.

● **Modifications**—Major change is in the second-stage diameter, which will be increased from 32 in. to 54.7 in., with length of 214 in., compared with the present 226 in. The extra propellant capacity—10,500 lbs., against 4,700 lbs. —will more than double burn time, yielding 398 sec. as against the present 160 sec.

Second-stage thrust will be uprated from 7,500 to 7,800 lbs., total impulse from 1,200,000 lb.-sec to 2,900,000 lb.-sec, and nozzle expansion ratio will go from 20:1 to 40:1.

The same Douglas-built guidance system will be used, but it is being repackaged to fit the new diameter and to provide increased flexibility and growth potential.

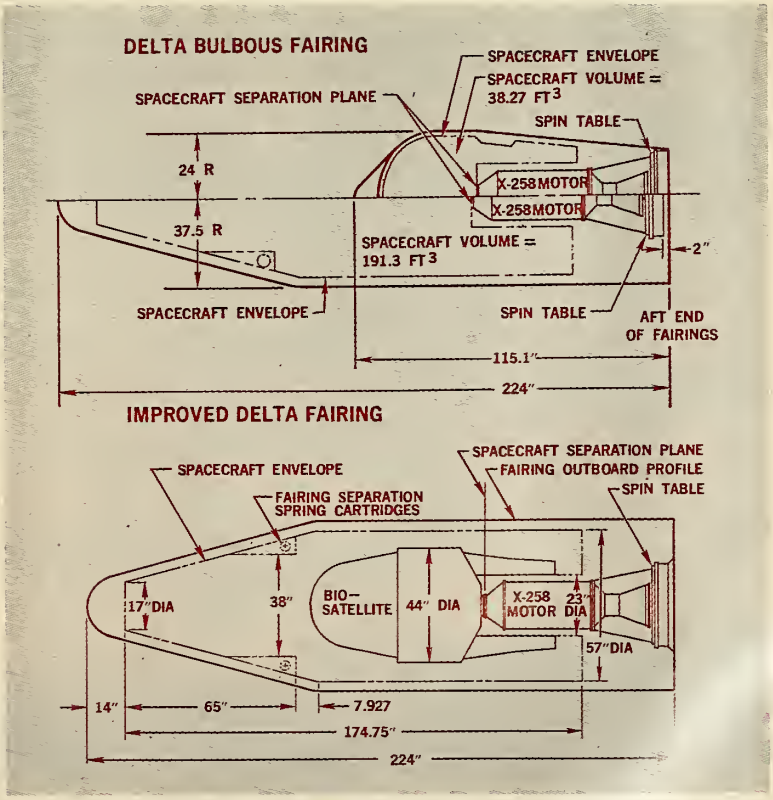
There will be no first-stage changes. Douglas spokesmen say no first-stage stiffening is required. *Improved Delta* will have a larger nose fairing, providing five times more spacecraft room. The shroud will measure 21 ft. long and 65 in. in diameter, with 186.9 cu. ft. of usable spacecraft volume compared with 38.27 cu. ft. in the present *Delta* bulbous fairing.

The fat tank upper stage and new fairing can be used with either the standard *Delta* or the *Thrust-Augmented Delta (TAD)*.

● **Schedule**—First flight of the new vehicle is expected in June next year following an April initial delivery. Subsequent deliveries will be at the rate of one per month.

Improved Delta is the fifth major step in growth of the basic *Delta* space launch vehicle, which has run up a reliability record of 22 successful launches out of 24 flights and has launched such spacecraft as *Echo*, *Syncom*, *Relay*, and *Telstar* communications satellites; the *Tiros* weather satellite series; *OSO; Ariel;* and several *Explorer* satellites.

Work will be done at the Missile & Space Systems Division's Santa Monica, Calif., and Tulsa, Okla., facilities, with some facility modifications to be made at the Cape Kennedy launch site. Other companies involved in the *Delta* program with Douglas include Aerojet-General, second-stage propulsion system; Rocketdyne Division of North American Aviation, first-stage propulsion; Thiokol, strap-on solid propellant boosters for *TAD;* Texas Instruments Co.; Honeywell, Inc.; Bell Telephone Laboratories; and Electro-Solids, Inc. ■



TOP: Delta fairing comparison. BOTTOM: Details of improved fairing.

AF Adopts New EBW Buy Approach

Air Logistic Command action on Sidewinder kits follows advice of firms advocating purchase as complete systems

by John F. Judge

OLMSTED AFB, PA.—The first major procurement of an exploding bridgewire (EBW) ordnance system as a complete system from a single contractor will be issued by the Middletown, Pa., Air Materiel Area of the Air Force's Air Logistic Command.

The request calls for the design and development of frequency coded armament system/exploding bridgewire modification kits for the *Sidewinder* air-to-air missile. The full procurement is estimated at about $1.3 million.

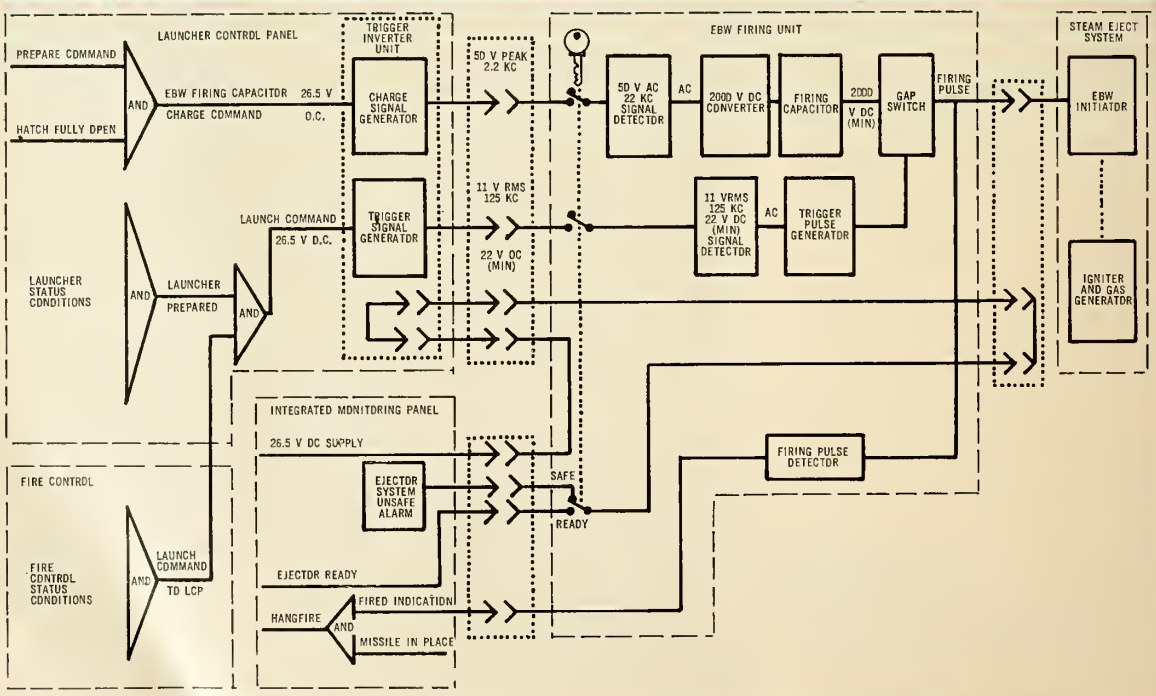
The Air Force approach is in line with the urgings of explosive ordnance firms, which have long claimed the only route to reliable and effective use of EBW hardware lies in treating it as a complete system.

The usual approach has been to split responsibility between the signal-generating components and the ordnance devices, and using two separate sources in industry.

The prime reason behind the procurement is to increase the safety of missile ignition systems—especially to prevent inadvertent operation caused by stray signals, RF and on-board malfunctions in the primary power supply and delivery.

Operational Air Force commands have long been concerned with the problem, and the Middletown AMA has been charged with the responsibility of coming up with a safe, effective system.

The actual procurement will be handled by the Missile Division, Directorate of Materiel Management. The Missile Division handles all operational air-launched guided missiles—*Side-*



EXPLODING BRIDGEWIRE firing circuit functional diagram.

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Has built a liquid rocket engine that demonstrated – in a series of altitude demonstration tests – the highest performance in its class to date. Tests were conducted by NASA at the Air Force Arnold Engineering Development Center facility at Tullahoma.

Has developed – for future space needs – a new high-energy, space-storeable liquid fuel: Utane.

Further reference: write UTC, Sunnyvale, California

United Technology Center DIVISION OF UNITED AIRCRAFT CORPORATION

winder, Falcon, Sparrow, Shrike, and *Bullpup.*

● **Savings foreseen**—The procurement will be handled through two-step negotiation procedures—an approach that will save the Air Force almost a quarter of a million dollars, since a great deal of the hardware exists.

The first step will be a request for a technical proposal for the design, manufacture and testing of the items. The second step will consist of a request for cost proposals confined to those firms submitting acceptable proposals in the first step.

The request also calls for any necessary work on associated launching and test equipment applicable to the F-86, F-100, F-104 and F-105 aircraft.

Technical personnel at Olmsted are aware of the existence of other approaches to the solution of the problem, and while the request does spell out a frequency coded EBW system, they are primarily interested in an economical—but effective—solution.

The compelling nature of increasing the safety factor is best illustrated by an incident in 1961 in which a B-52 was destroyed when a *Sidewinder* was inadvertently launched from an Air National Guard F-100A while on a training mission.

● **Nature of EBW**—An exploding bridgewire is a wire that is subjected to electrical current flow far beyond its current-carrying capacity. It then explodes, releasing hot particles and gases accompanied by a shockwave in excess of Mach 50 and temperatures approaching 5,000°K.

Exploding bridgewires have been used to initiate explosives in missile ordnance functions—such as engine ignition, stage separation and thrust termination—since about 1957. The major advantage of exploding bridgewire over other initiating methods is in the ability to elminate sensitive primary explosives and substituting the high energy produced by the exploding wire.

This made the direct ignition of secondary explosives such as PETN and RDX possible. The result was a considerable improvement in safety.

In a paper prepared for a recent conference on explosive ordnance systems, O. W. Schreiber, director, Electronic Engineering Dept., Librascope Group of General Precision, Inc. (now with McCormick Selph Associates) and W. F. Guenther senior electrical engineer, Sunnyvale Div., Westinghouse Electric Corp. described the application of frequency coded armament systems to the *Polaris* missile launch system. The application is not typical but will serve to describe what a frequency coded EBW system is.

According to Schreiber and Guenther, a fast-rise time, high current magnitude pulse is required to explode the bridgewire. The normal method is through capacitor discharge. Since the EBW system is not a closed one, some form of intelligent direction is required for its operational sequence. There is also a limit on the peak power demand on the primary power source.

From these requirements evolved the now conventional operational mode of a "charge" command input to store energy in the capacitor, and a "trigger" command input to release this energy for ordnance ignition.

● **Inadvertent discharge**—The charge command input is vulnerable to an excessive voltage input, which charges the capacitor to a voltage exceeding the triggered spark-gap rating—with consequent inadvertent discharge.

Schreiber and Guenther cite input voltage regulators or voltage-limiting devices to protect against such discharge.

But the trigger command input is the point of critical vulnerability, say the authors. There are three classes of electrical signals that must be prevented:

—Stray currents and noise voltages due to leakage or crosstalk from adjacent circuits or from ground circulating currents.

—Inadvertent application of primary power through component failure.

—Radio-frequency signals from radar and radio transmitters.

There are many approaches to preventing inadvertent discharge, but the one major method considered here grew out of work presented by M. Loyd of Librascope at the HERO congress in 1961. Schreiber and Guenther say the Loyd paper showed that near-optimum protection against RF energy and stray current could be achieved by a zero-frequency signal—a d-c trigger input received through a low-pass filter or discriminator.

This system presented virtually no protection against false or inadvertent application of primary power. But further study revealed that the trigger required a unique signal, not duplicated by any other signal existing in the EBW system environment.

● **Simplicity stressed**—Schreiber and Guenther point to the obviously large number of signal configurations that could be developed to answer the requirement, but described their approach as starting with the high degree of protection that already existed in the d-c trigger signal. This was coupled with an attempt to minimize the amount and complexity of added circuitry. The result was selection of a composite signal of d-c and coincident low-frequency a-c to provide trigger input protection.



Pictured above are only three of many New Orleans advantages:

REASON ONE—The Mississippi River Gulf Outlet (foreground), new $100 million shortcut for ocean shipping from New Orleans to the Gulf, has opened many acres of choice, deep-water industrial sites within the city limits.

REASON TWO—The NASA Michoud complex (right background), where mighty Saturn space boosters are manufactured. This vast operation and the nearby Mississippi Test Facility have spurred much allied industrial growth in the eastern area of New Orleans.

REASON THREE—Public Service's new Michoud Electric Generating Station (left foreground), symbol of the modern facilities which serve New Orleans with dependable, low-cost electricity.

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The system design is still bound by the requirement to derive all system power from a primary source—typically a 28v d-c battery. Use of this unique trigger signal requires the addition of a trigger generator to the system—placed in as close electrical proximity as possible to the primary power source.

This final system, say the authors, was christened the "frequency coded armament system."

The FCAS approach was used in developing the present *Polaris* missile launching system at Westinghouse Electric Corp. This system uses a small, solid-fuel rocket to generate steam to eject the missile from the launch tubes. The FCAS/EBW system is employed to ignite the solid gas generator.

● **Different environment**—The system design is for the submarine environment and includes an additional requirement of protection against unauthorized use. The design approach to flying hardware would be somewhat different in detail, but the general outline would be similar.

The physical elements of the *Polaris* launcher ignition system consist of a trigger inverter unit and a firing unit. The trigger inverter unit generates two unique signals for the charge and trigger functions, which are, in turn, transmitted to the firing unit.

When the launching system is to be made ready for firing, the first step is to place the firing unit key-lock switch in the "ready" position. When the command to "prepare" is received from the fire-control center, the hatch over the selected launch tube is opened.

The coincidence of the prepare command and the "hatch fully open" signal generates the EBW charge command to the Trigger Inverter Unit (TIU), which generates a 50-v square wave at 2,200 cps, transmitting this to the firing unit.

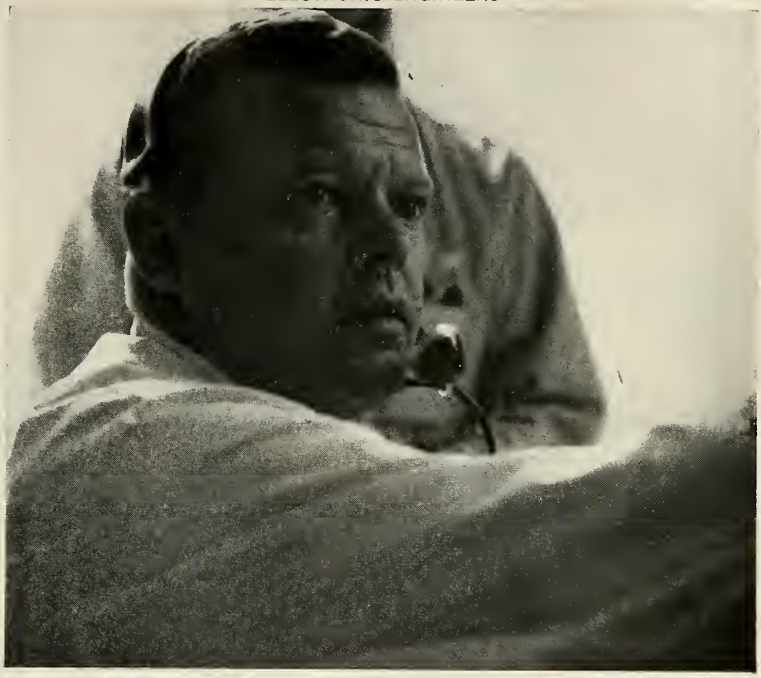
When all launcher conditions for firing have been met, a "launcher prepared" signal is generated. This signal and the receipt of launch command from fire control will initiate the fire command to the TIU. The trigger signal generated by the TIU is a coincident dc and 125-kc signal, which is transmitted to the firing unit.

If accepted by the discriminator circuit, the gap switch is triggered and the firing pulse delivered to the EBW ignition device.

A "fired" sensing circuit detects this firing pulse output and energizes a timing circuit in the firing unit. The firing circuit closes its output contacts in approximately one second. If the missile has not lifted within this time, a hangfire signal is generated and the tube hatch held in the open position.

At missile away, the charge and trigger commands are removed from the TIU. ■

ELECTRONIC ENGINEERS



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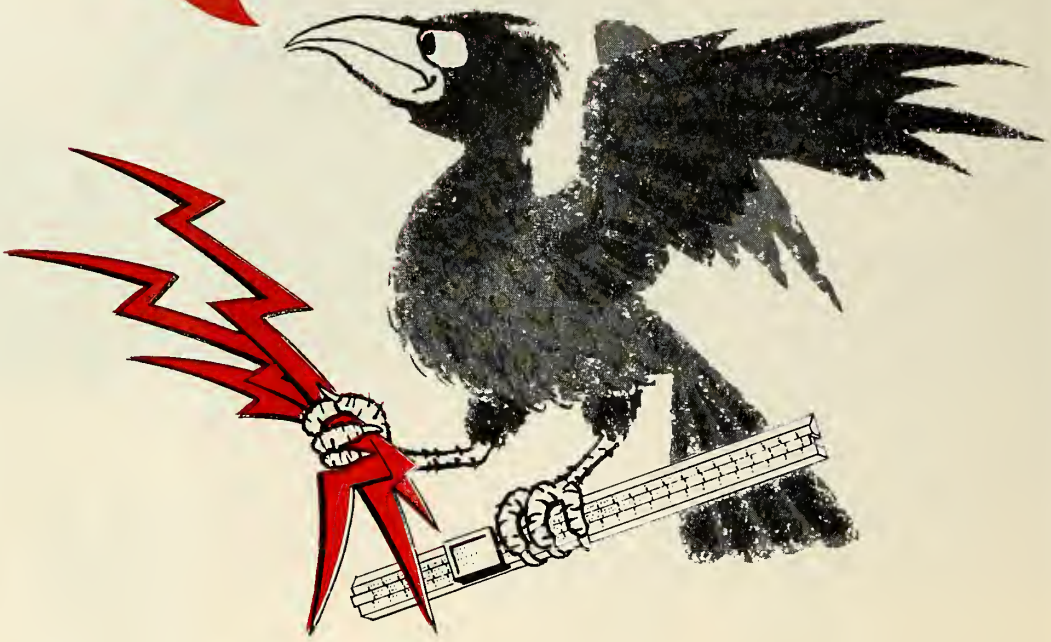
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Conversion of Singer Installation To Be Completed Within 18 Months

Ambitious acquisition program creates Metrics-East, -West, marking switch to production of test, measurement equipment

by Charles D LaFond

BRIDGEPORT, CONN.—A total plant conversion from industrial sewing machine manufacture to R&D and production of precision test and measurement equipment will be completed here by The Singer Company, Metrics Division, within 18 months.

Singer has invested more than $30 million to create its new division during the past 2½ years. It is doing so almost completely by acquisition, having purchased four prime instrument companies since the fall of 1962, plus acquiring the entire product line of a laboratory test equipment manufacturer not equipped to market its own line.

Some 60 to 65% of Singer-Metrics' more than $30 million annual gross today is in the aerospace/military fields. Through continued acquisitions and projected annual sales increase of 10-15% on each department product line, the metrology division is reaching for a $50 million annual gross within 5 years.

Relocation of three acquired firms to the Bridgeport facility (Metrics-East) is now complete. The recent purchase of Gertch Products, Inc., Los Angeles, is the first of several planned West Coast acquisitions which will, after relocation, comprise Metrics-West.

● **A unique experience**—In 1961, The Singer Co. was faced with an enlarged bank account. It was benign, however, and the decision was made to reduce this relatively non-productive growth and at the same time make better use of the firm's existing manufacturing facilities.

Also, the company had already begun to diversify into other consumer areas and it was felt that the organization image would benefit by increasing its in-house research and development capability.

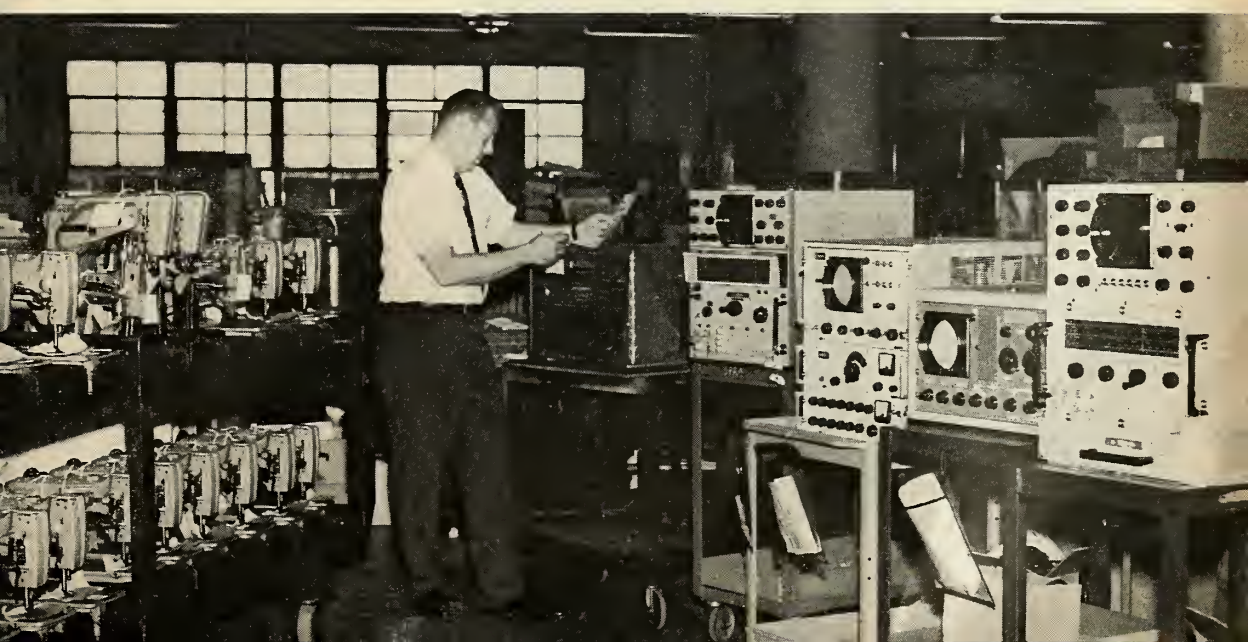
The firm, in early 1962, hired Kenneth M. Miller, then vice president and general manager of Daystrom, Inc.'s Pacific Division. He is now Metric's Division general manager. He was offered the unique experience of selecting a field of interest and then establishing by acquisition an integrated manufacturing facility and supporting marketing organization that would fit certain ground rules predicated by Singer management. These included:

1) A product line within a limited field offering profits of at least 10% after taxes on invested capital.

2) A capability based on continued R&D and assuring a quality line of proprietary products.

3) A facility capable of rapidly achieving minimum gross sales of $30 million and an annual minimum growth

SINGER-METRICS shipping room still shows signs of old and new—industrial sewing machines (left) and measuring instruments.



rate of 10% (preferably up to 15%).

4) The use of the 10-year-old Bridgeport facility with its 1,500 employees.

● **The instrument field**—Miller, whose entire background had been in electronics, eventually narrowed the field to the electronic/electrical instrument industry. Several existing and reasonably reliable market surveys, including his own, placed this industry's annual gross at about $600 million.

He then further narrowed the field to that of very high-precision metrologic instruments and selected some 200 firms from which to make his acquisitions. These were further narrowed to a more select group within a possible price range of $2-12 million and possessing both a high quality and a strong proprietary product line.

In rapid succession, four companies were purchased. First, in September, 1962, Panoramic Electronics, Inc., a leading producer of broadband spectrum analyzers, communications system analyzers, frequency-response plotters and telemetry system test instruments, was brought into the fold, including all its top management, engineering and market personnel. William I. Wu, a former Panoramic vice president, was made director of R&D and chief engineer for Metrics and also became a principal aide to Miller in determining the technical capabilities of companies selected for future acquisition.

Sensitive Research, Inc., was acquired in January, 1963, and Empire Devices, Inc., followed last September. The Empire line included noise and field intensity meters, sensitive RFI receivers and direction finders, signal generators, microwave components, and associated test instruments. Sensitive Research produced extremely precise indicating instruments, including voltmeters, wattmeters, magnetic testers, and laboratory standards.

Gertch Products, acquired early this year, has a complementing line of frequency meters, ratio transformers and voltage dividers, ratio bridges and phase standards plus synchro/resolver testers.

From three to five more companies will be purchased, Miller says, probably on the West Coast. These probably will be in the less-than-$10-million price range.

● **Market and sales**—Miller claims that 50% of the total $600 million instrument market today is controlled by 15 companies. The biggest of these are Hewlett-Packard and Tektronix, with General Radio and Singer-Metrics roughly tied for third place. Singer's planned acquisitions should soon place it firmly in third place, Miller says. (Current Singer-Metrics sales are estimated to be in the $20-22 million range.)

The new division has no plans at present to extend its instrument range into the optics range, but it does plan to employ microminiaturized circuits in future instrument design.

While its R&D group will build an integrated-circuit in-house capability, he asserts, the Metrics Division will probably buy circuits outside. The stress, he disclosed, will always be to produce high-quality state-of-the-art equipment.

In time, the division will move toward an integration of some of its instruments and build a test and measurement systems capability. (A survey of proprietary instruments already on hand seems to point to a ready capability for ECM, ECCM, and RFI systems.)

To prevent undermining its sales capability, products from each acquired firm will retain part of their original trademarks—Panoramic, Sensitive Research, Empire, and Gertch—but will have the Singer-Metrics name added.

A new Singer exterior (beige) will be introduced for uniformity of design, and most instruments will require or have already experienced some internal redesign to meet rigid quality control standards set up for the division.

An expected outgrowth of the four acquisitions was an unwanted overlap in sales representation. In some cities, as many as nine different manufacturers' representatives were marketing the Metrics line.

Now, a total of nine manufacturers' representative companies provide some 95 reps for all Singer-Metrics U.S. sales, with no duplication of effort in any city. The bulk of these are located in the northeast and southwest regions of the country.

To further strengthen its sales force morale, termination clauses in all contracts have been extended from what was one month to 12 months. Both sales and buyer personnel confidence apparently has increased now that the direction and intent of Singer-Metrics is based on fact rather than promise.

● **Facility changes**—The Bridgeport plant is roughly 10 years old, one of the newest large facilities in this heavily industrial city. Some modernization will be required, Miller says, to upgrade the facility for instrument production.

Clean rooms have been introduced largely for the production of laboratory standards. Stable tables and some isolated pads will also be built. Biggest problem at the present time, since some sewing machine production is still continuing, is successfully isolating production areas from precision measurement areas.

As the industrial sewing machine production has been shifted to other U.S. plants and to Singer plants in Scotland, Australia and Japan, personnel at Bridgeport have been retrained and reassigned. Machinists had little trouble in the changeover, but assembly workers have been through an intensive re-education. ■



METRICS DIVISION General Manager Kenneth M. Miller.



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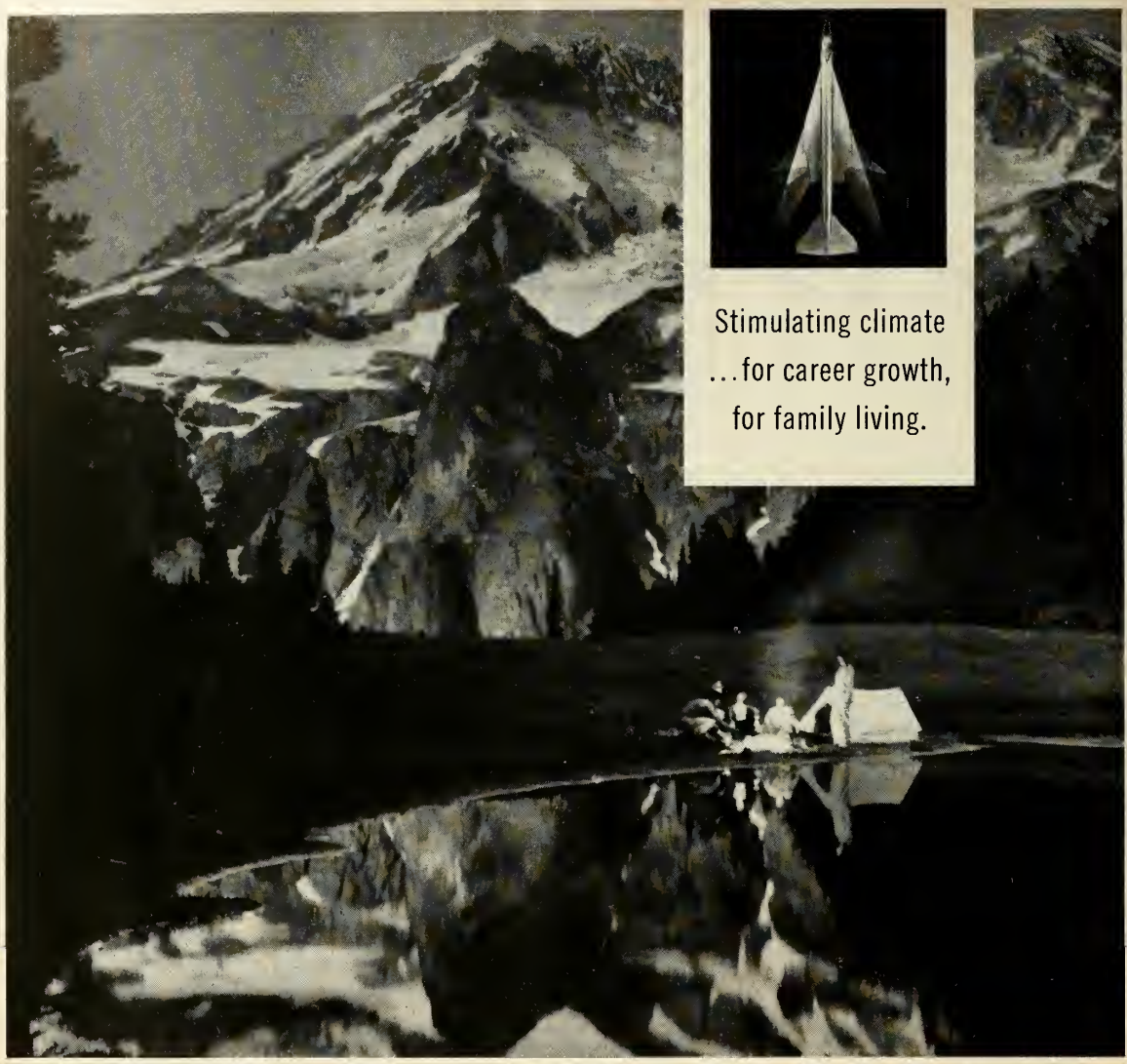
...maintenance and operation of systems such as the DEW Line and the electronic instrumentation and communications facilities at Point Arguello for PMR.

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New Activities

Eastman Kodak Co., Rochester, N.Y., and Consolidated Electrodynamics Corp., Pasadena, Calif., have made a joint entry into the magnetic instrumentation recording tape field. Eastman, in association with CEC, has developed a new family of magnetic tapes for use in instrumentation recording systems. CEC will market the tapes, which are designed for use on virtually any type of instrumentation recorders. The tapes will be available in four types—W-1 (1.5 mc), M-1 (600 kc), SX-1 (300 kc), and S-1 (100 kc). . . . *Emerson Electronics and Space Div. has reorganized and expanded its marketing department. Included in the move are new divisional offices in Atlanta, Ga., and Dayton, Ohio.* . . . John Oster Manufacturing Co.'s Avionic Div. has been renamed Sunbeam Electronics—Components Div. The renamed facility will continue to operate in Racine, Wisc., as a division of Oster until early next year, when it will be moved to Fort Lauderdale, Fla. Oster is a subsidiary of Sunbeam Corp. . . . *Pall Corp., Glen Cove, N.Y., has formed a new division to extend its activities in environmental control systems, particularly as applied to aerospace ground support, electronic equipment and industrial processes.* . . . The Cryogenic Society of America has been formed by a group from industry, university faculties and government agencies. The society has been registered as a non-profit society in California. Membership will be open to individuals with an interest in any area of cryogenics, from basic research through direct application in industry. The new organization will cooperate with the Cryogenic Engineering Conference and will explore the possibility of publishing a magazine for members.

Mergers and Acquisitions

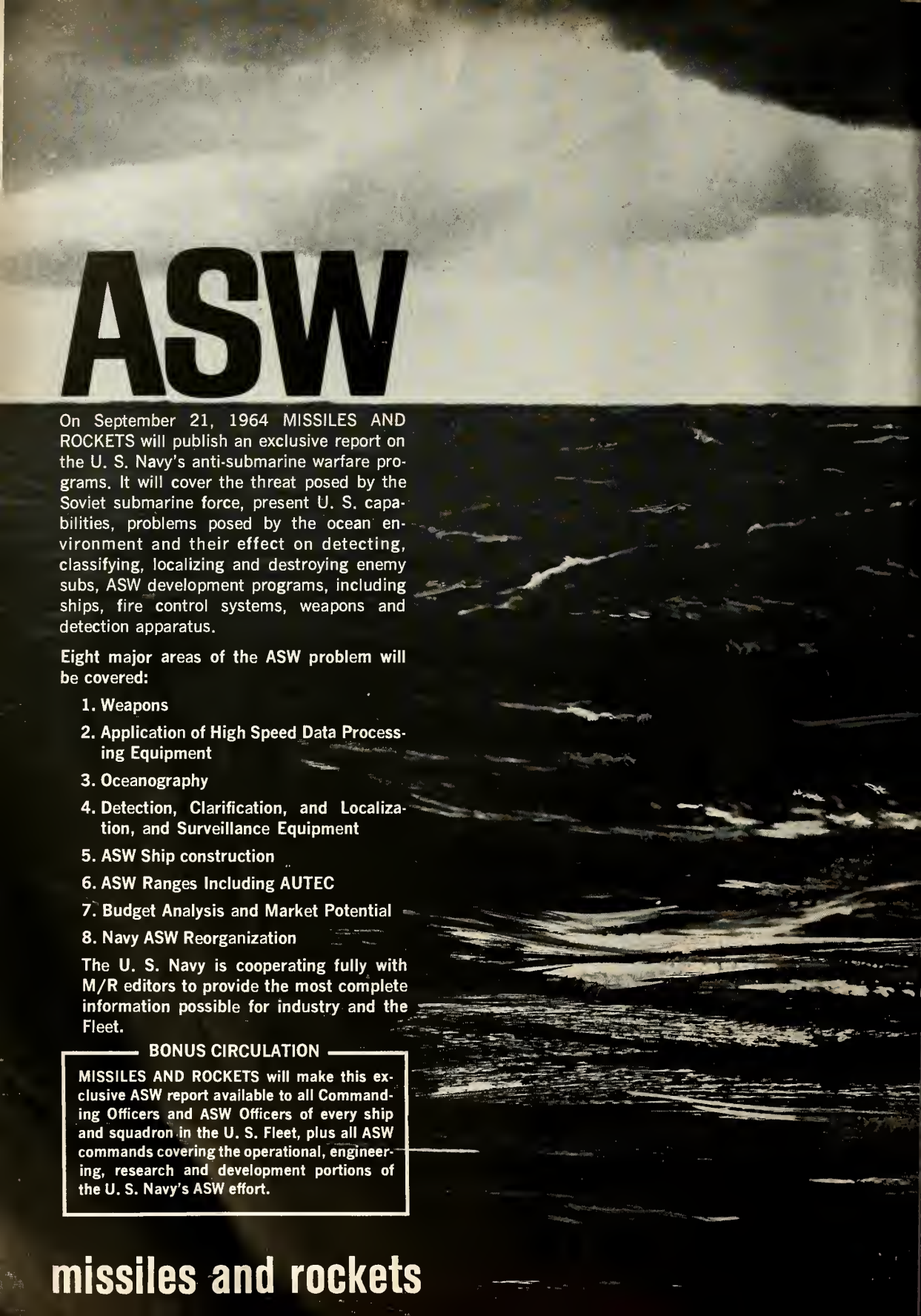
Haveg Industries, Inc., stockholders have approved an acquisition of that firm by Hercules Powder Co. Haveg, Wilmington, Del., designers and fabricators of engineered plastics, recently acquired the aircraft seals business of Connecticut Hard Rubber Co., New Haven, Conn. . . . *The boards of directors of Abbott Laboratories, Chicago, and Nuclear-Chicago, Des Plaines, Ill., have approved a merger of the two firms. Nuclear-Chicago makes instruments for detecting and measuring nuclear radiation; Abbott manufactures pharmaceuticals, chemicals, animal health products and specialized nutritional products.* . . . Central National Bank in Chicago has purchased Radio Corp. of America's midwest electronic data processing center, effective Sept. 1. Central National Bank will use the center to increase its capacity to handle its own data processing and that of correspondent banks and commercial customers. . . . *Vac-Hyd Processing Corp., Torrance, Calif., has acquired Alphatizing, Inc., a chromium diffusion process firm, and will operate it as a division.* . . . Consolidated Ceramics and Metalizing Corp., Flemington, N.J., has purchased the equipment and inventory of Metalizing Industries, the metalizing division of Kawecki Chemical Co. Metalizing Industries has been active in the field of silver metalizing of ceramics.

Kidde Gets Airpower Award

Walter Kidde & Co., Inc., has received the Air Force Association New Jersey Wing 1964 Airpower Achievement Award for outstanding contributions in aerospace. The citation makes particular mention of Kidde's control system aboard the Syncom II satellite.

Industry Facilities

Curtiss-Wright Corp. has contracted to lease the New York State Atomic and Space Development Authority's Malta Test Station at Ballston Spa, N.Y., for one year's exclusive use. The station is the only state-owned rocket development and test facility in the U.S. Work to be performed there by Curtiss-Wright will involve development and testing of small rocket engines and components. The contract is renewable for up to four years. . . . *Westinghouse Electric Corp.'s Astronuclear Laboratory has installed a new space materials mechanical test machine in its Pittsburgh facility. The unit will be used for evaluation of metals and alloys being explored in space power system work done by the lab. Varian Associates built the unit, which is capable of operating with vacuums of 10^{-8} torr and below at temperatures around 3,500°F.* . . . The Aerospace Div. of Atlas Chemical Industries, Inc., has opened a glass-to-metal seal facility in Valley Forge, Pa. The operation aims at making it possible for "aerospace components manufacturers . . . to order seals which are completely suited to their products instead of adapting their products to standard seals." . . . *The University of California (Los Angeles) will begin construction this month of a 30-laboratory space center building, costing $2 million to be paid for entirely by NASA. The new facility will be the headquarters for UCLA's Space Science Center and will serve as a focal point for space-oriented research in the physical sciences, bio-medical sciences, engineering and business administration. The six-story, 67,000-sq.-ft. building will house 30 large laboratories and 50 research and administrative offices.*



ASW

On September 21, 1964 MISSILES AND ROCKETS will publish an exclusive report on the U. S. Navy's anti-submarine warfare programs. It will cover the threat posed by the Soviet submarine force, present U. S. capabilities, problems posed by the ocean environment and their effect on detecting, classifying, localizing and destroying enemy subs, ASW development programs, including ships, fire control systems, weapons and detection apparatus.

Eight major areas of the ASW problem will be covered:

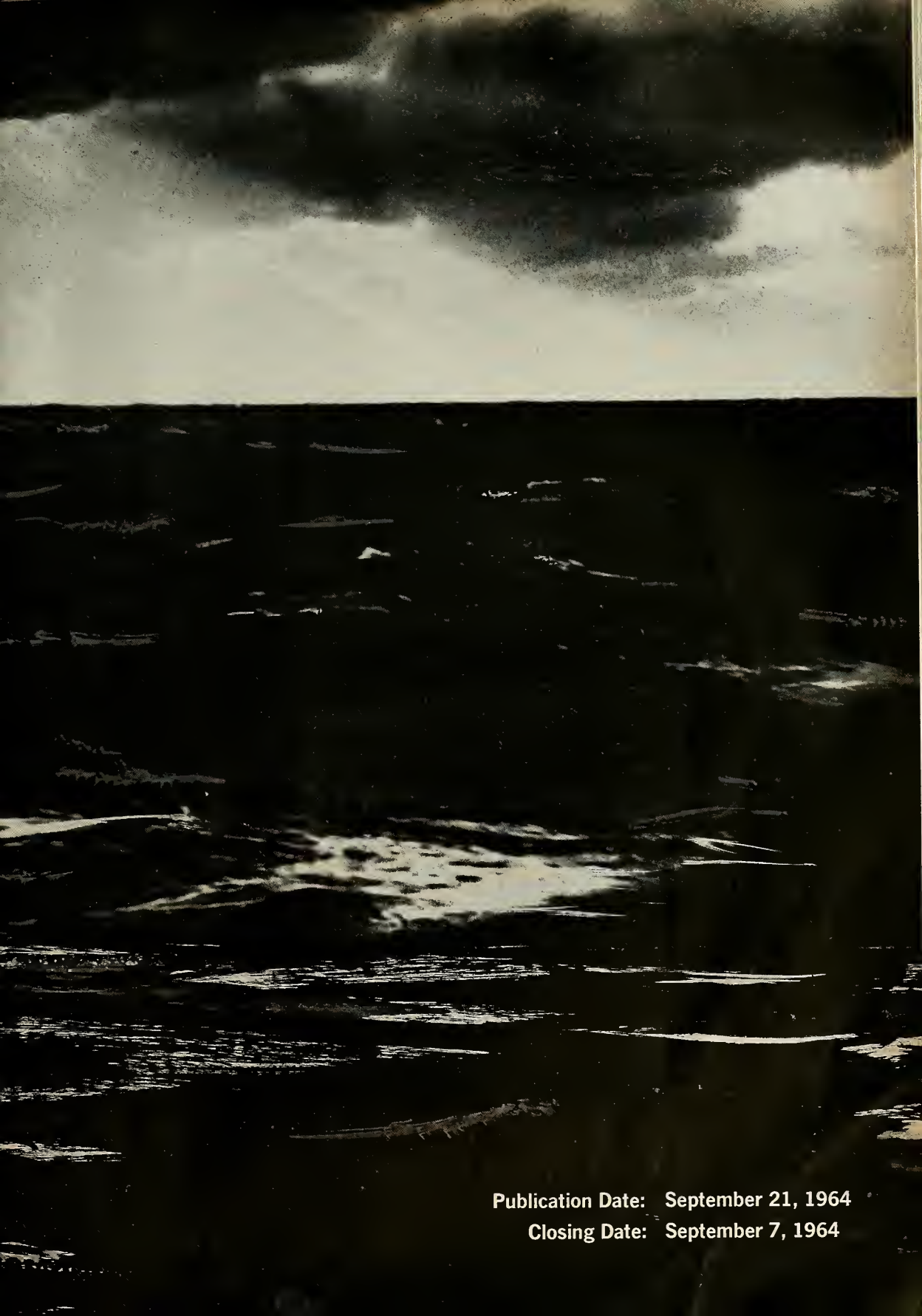
1. **Weapons**
2. **Application of High Speed Data Processing Equipment**
3. **Oceanography**
4. **Detection, Clarification, and Localization, and Surveillance Equipment**
5. **ASW Ship construction**
6. **ASW Ranges Including AUTEC**
7. **Budget Analysis and Market Potential**
8. **Navy ASW Reorganization**

The U. S. Navy is cooperating fully with M/R editors to provide the most complete information possible for industry and the Fleet.

BONUS CIRCULATION

MISSILES AND ROCKETS will make this exclusive ASW report available to all Commanding Officers and ASW Officers of every ship and squadron in the U. S. Fleet, plus all ASW commands covering the operational, engineering, research and development portions of the U. S. Navy's ASW effort.

missiles and rockets



Publication Date: September 21, 1964
Closing Date: September 7, 1964

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ELECTRO OPTICS

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contracts and procurements

AWARDS

AIR FORCE

$21,669,000—**North American Aviation, Inc.,** Anaheim, Calif., to make various parts for the improved *Minuteman* guidance system.

$11,300,000—**ITT Federal Laboratories,** Nutley, N.J., to provide radar and electronic equipment.

$8,000,000—**Hercules Powder Co.,** Wilmington, Del., for the manufacture of first-stage rocket motors for the improved *Minuteman* missile.

$2,000,000—**General Electric Co.,** Evendale, Ohio, for design, development and evaluation of components.

$737,000—**Philco Corp.,** TechRep Div., Philadelphia, for a classified contract covering equipment installation.

$600,000—**General Motors Corp.,** AC Spark Plug Div., Milwaukee, Wisc., to update the *Titan II* inertial guidance system.

$555,000—**Ling-Temco-Vought, Inc.,** Astronautics Div., Dallas, cost-plus-incentive-fee contract for *Gemini* experiment modular maneuvering unit.

ARMY

$14,100,000—**ITT Federal Laboratories,** Nutley, N.J., to furnish equipment and install communications systems.

$3,500,000—**Collins Radio Co.,** Dallas, to produce transportable radio terminals.

$3,298,562—**Radio Corp. of America,** Services Co. of Cherry Hill Div., Camden, N.J., to construct a solar simulator.

$213,471—**Brown Engineering Co., Inc.,** Huntsville, Ala., for support of R&D technical programs for missiles, including laser research and missile penetration aids.

$203,400—**Martin Marietta Corp.,** Orlando, Fla., for modification of programmer test station trainers for *Pershing* missile system; also $52,000 for safety range kits for *Pershing* and $90,062 for *Pershing* spare parts.

NAVY

$225,952,288—**Lockheed Aircraft Co.,** Sunnyvale, Calif., to make *Polaris* missiles.

$55,518,666—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., to make improved *Polaris* missiles and supply technical services to *Polaris* systems.

$47,820,000—**General Dynamics Corp.,** Electric Boat Div., Groton, Conn., for design and construction of a new nuclear powered attack submarine.

$2,783,818—**General Dynamics Corp.,** Pomona, Calif., to manufacture *Terrier* surface-to-air missiles.

$1,350,000—**General Precision, Inc.,** GPL Div., Pleasantville, N.Y., to produce an advanced data display system for the Navy's Operations Control (OpCon) Center.

$1,096,544—**North American Aviation, Inc.,** El Segundo, Calif., to install motors in the *Sidewinder* missile.

$823,818—**ITT Research Institute,** Chicago, for R&D in the field of counter-countermeasures.

$534,900—**United Aircraft Corp.,** United Technology Center Div., Sunnyvale, Calif., for R&D on a variable thrust injector development program.

$450,038—**Texas Instruments, Inc.,** Dallas, for R&D and production of *Shrike* missile.

$320,000—**Thiokol Chemical Corp.,** Reaction Motors Div., Denville, N.J., for two R&D programs: (a) to exploit compound A-based liquid bi-propellant, and (b) integral radially distributed annular combustor for prepackaged liquid rocket engines.

$278,000—**Honeywell, Inc.,** California Ordnance Branch, West Covina, Calif., for design and field engineering services on the *Asroc* development program.

ADVANCED RESEARCH PROJECTS AGENCY

$200,000—**Vitro Corp.,** Vitro Laboratories Div., Washington, D.C., for further investigation of sea-launched ballistic missile defense problems.

NASA

$1,540,098—**Dow Chemical Co.,** Midland, Mich., for facilities engineering support services at Kennedy Space Center.

$1,352,000—**General Dynamics Corp.,** Convair Div., San Diego, for two more *Little Joe II* launch vehicles, used as boosters in the *Apollo* program.

$700,000—**North American Aviation, Inc.,** Space and Information Systems Div., Downey, Calif., for a study to determine additional uses of the *Apollo* spacecraft.

$644,250—**United Aircraft Co.,** Pratt & Whitney Div., West Palm Beach, Fla., for investigation of flight hydrocarbon fuels with flox mixtures as liquid rocket propellants.

$538,955—**Lockheed Aircraft,** Missile and Space Div., Sunnyvale, Calif., for development of thermal protection system for a cryogenic spacecraft module.

$414,500—**Thiokol Chemical Corp.,** Denville, N.J., for investigation of oxygen difluoride dihorane propellant combination.

$275,000—**Motorola Inc.,** Military Electronics Div., Scottsdale, Ariz., to provide transponders for the *Saturn* booster test program.

$250,000—**Marquardt Corp.,** Van Nuys, Calif., for development of a reciprocating-hypergolic engine space power system.

INDUSTRY

$6,000,000—**Federal-Mogul-Bower Bearings, Inc.,** Arrowhead Products, Los Alamitos, Calif., from **The Boeing Co.,** Seattle, to produce parts for the *Saturn V* rocket.

$2,000,000—**Model Engineering and Manufacturing Corp.,** Courter Products Div., Boyne City, Mich., from **Maxson Electronics Corp.,** Great River, L.I., N.Y., for a two-year production order for gyroscopes used in the *Bullpup* missile.

$800,000—**ITT Corp.,** ITT Industrial Products Div., San Fernando, Calif., from **Martin Marietta Corp.,** Orlando Div., Orlando, Fla., follow-on contracts for additional exploding bridgewire ordnance initiator firing units for the *Pershing* missile.

$773,000—**G. T. Schjeldahl Co.,** Northfield, Minn., from **Fairchild Stratos Corp.,** Space Systems Div., Bladenshurg, Md., for fabrication of 672 thin-film meteoroid detectors to he installed in three Meteoroid Measurement Capsules (MMC's) with the first scheduled for launch hy a *Saturn* hooster from Cape Kennedy late this fall.

$250,000—**Consolidated Systems Corp.,** Monrovia, Calif., from **Sandia Corp.,** Alhuquerque, N.M., for the manufacture of 80 *Nike-Tomahawk* sounding rocket payloads.

$121,400—**Giannini Controls Corp.,** Duarte, Calif., from **General Electric Co.,** Missiles and Space Systems Div., Philadelphia, for pressure transducers to he used in re-entry vehicle instrumentation.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Directorate of R&D Procurement
Systems Engineering Group (RTD)
Wright-Patterson AFB, Ohio

Negotiations will he conducted with Lockheed-Georgia for test hattery to he used in the *Manned Orbiting Laboratory*. For information only; RFP not availahle.

Contracts Office
George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Huntsville, Ala.

Request for quotation for production support services for the RL-10 engine program. Only Pratt & Whitney Aircraft, West Palm Beach, Fla., will he invited to participate; any firm interested in the procurement should make direct contact with the ahove firm.

Bureau of Naval Weapons
Washington, D.C. 20360

A proposal will he solicited from Goodyear Aerospace Corp., Akron, Ohio, for a quantity of *Subroc* missiles. It is the Bureau's position that only the ahove firm can he reasonahly expected to deliver quality equipment within a short production lead time.



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Link has put a lot of birds in the air. Make-believe birds like the Edwards Space Flight Simulator. Others like the F-4C, F-8E, C-135B, C-130 and B-727 Flight Simulators. More, like T-26 and 2B13 Trainers.

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New Product of the Week: Laser-Raman Spectrometer



Scientists from the Perkin-Elmer Corp. in Norwalk, Conn., report first application of a laser excitation source for a new commercially available Raman spectrometer.

Application of a CW helium neon gas laser in the instrument, according to the firm, has enabled development of Raman instrumentation that is lower in cost and less complex in equipment and operation than previous systems. Studies of the Raman effect previously have been carried out with a mercury arc light source for excitation and chemical solution filters to isolate the desired spectral lines, according to the firm.

Use of the laser, Perkin-Elmer points out, is less likely to cause photodecomposition of the material sample under study, and in many instances will permit the running of colored samples, which would normally absorb the shorter exciting wavelengths of the mercury source. Lasers also make depolarization measurements easier, they note, since the laser output is highly plane-polarized and well collimated. Filter solutions and cooling systems are not required and the sample is easily accessible and less likely to suffer heat damage, they add.

The device, including laser and optics, requires lab bench space of about 2 x 3 ft. and one rack of equipment including recorder.

The Raman method, which involves a second order scattering effect rather than an absorption phenomenon as in infrared (though the two methods complement each other in the overall field of spectrometry), is used primarily for structural studies of molecules and analysis of chemical samples. In some cases, this techniqc, according to the firm, also offers possibilities for rapid, simple, and accurate analysis of certain mixtures that are troublesome with any other method.

In the Perkin-Elmer Laser-Raman system, the laser's highly monochromatic light falls on a sample and scatters. The scattered radiation consists not only of the original exciting light but also of additional light (the Raman lines) which is very weak and differs in wavelength from the exciting light. The differences between the two, in terms of frequency, relate to molecular vibration frequencies characteristic of the sample.

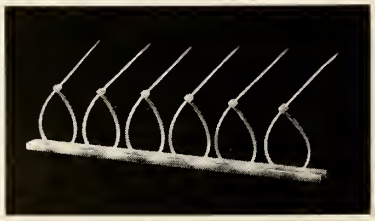
Circle No. 151 on Subscriber Service Card

Mounting Plate

A multiple mounting base designed for high-density wiring applications has been introduced by Thomas & Betts Co.

The unit can be used to install up to six wire bundles in close proximity.

A screw hole in each end and one between each cable bundle provide secure mounting. It is also available with a solvent-activated adhesive backing that binds the base to any surface. The nylon base can be used with twist type tie or the self-locking tie.



Circle No. 152 on Subscriber Service Card

Cryogenic Check Valve

A cryogenic check valve capable of withstanding temperatures as low as —320°F has been announced by James, Pond & Clark, Inc. The valve is designed for use in critical ground support and aerospace applications.

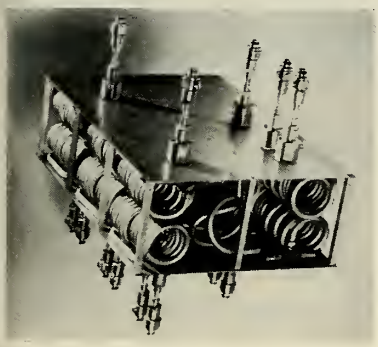
The KH200 series features stainless steel construction, LOX cleaning and cryogenic testing. Leakproof sealing is achieved by use of an O-ring compounded of cryogenic Teflon. The valve

features quick opening at pressure differentials as low as 0.1 psi and operates at pressures up to 6,000 psi.

Circle No. 153 on Subscriber Service Card

Narrow Band Hybrids

Phelps Dodge Electronic Products Corp. has developed a line of narrow-band hybrids fabricated of semi-flexible coaxial cables.



Isolation exceeding 40 db is said to be a minimum of 10 db better than can be achieved by broadband types. VSWR is less than 1.05 and power split is within ±0.1 db. Insertion loss is 3.1 db. Mechanical length tolerances of ±0.002 in. and bend radii of ±3/16 in. are attained.

Circle No. 154 on Subscriber Service Card

Summing-Isolation Amplifier

Kearfott Div. of General Precision Aerospace is marketing two ac summing-isolation amplifiers providing impedance isolation to prevent loading of signal sources. The 400-cycle amplifiers have both 180-degree and 0-degree linear outputs.

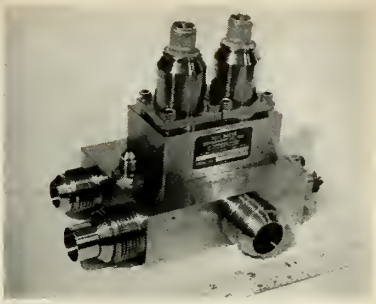
The Model C70 3180 001 has four signal inputs and a summing accuracy of ±0.02%. Signal input range is 0 to 26v RMS and gain stability is ±0.02. Model C70 3180 002 has a summing accuracy of ±0.05% for two signal inputs. Signal input range is 0 to 4v RMS with a gain stability of ±0.1. Both units have a 40-v maximum signal voltage and an operating temperature range of −55° to 125°C.

Circle No. 155 on Subscriber Service Card

Throttling Valves

Fox Valve Development Co., Inc., has introduced a line of remotely actuated cavitating venturi throttling valves suitable for aerospace, nuclear and commercial applications.

Standard valves are stainless steel construction with compatible elastomeric or bellows type seals. Hydraulic, propellant, electric motor or manual drives are optional. Typical throttling valves enable engine thrust drive variation from 20 to 200:1, depending on engine design parameters. Drives are digital signal type and demand power only when thrust level is changed.



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RF Wattmeters

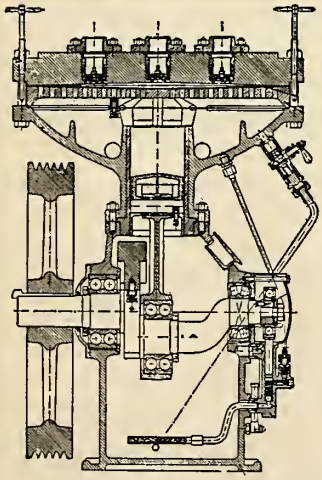
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Norman W. Rosenberg: Was presented DOD's Distinguished Civilian Service Award for his studies on the ionosphere. He is with Air Force Office of Aerospace Research, Cambridge Research Labs in Cambridge, Mass.

P. W. Perdriau and Harry B. Warner: Elected to be group vice presidents of B. F. Goodrich Co., Akron, Ohio. Perdriau will continue to serve as president of B. F. Goodrich Tire Co.; his new position will include responsibility in the B. F. Goodrich Aerospace and Defense Products Div. Warner will have responsibility for several operating divisions of the company, including the B. F. Goodrich Chemical Co., of which he had been president since 1960.

Hilliard W. Paige: Elected vice president of General Electric Co., Philadelphia. He is general manager of GE's Missile and Space Div.

Ezra S. Krendel: Named to the Research Advisory Committee on Control Guidance and Navigation with NASA. He is technical director of the Operations Research Div. of the Franklin Institute Labs, Philadelphia.

Raymond N. Watts, Jr.: Appointed supervisor of technical publications at the Applied Research Lab of Sylvania Electronics Systems, New York City.

Sam L. Ackerman: Appointed vice president-operations of General Dynamics/Electronics, Rochester, N.Y. He will be responsible for all operating functions—research, engineering, manufacturing and quality control.

Edward F. Briggs: Named a vice president of the Johns-Manville Sales Corp. and general sales manager of the newly-formed Aerospace Products Dept., New York City.

Norman J. Schuster: Appointed manager of the microelectronic equipment design section of the Data Systems Div. of Litton Industries, Beverly Hills, Calif.

Stanley V. Seiffert: Joined Rocket Research Corp., Seattle, Wash., as head of instrumentation engineering. He is a specialist in electronic instrumentation.

Walter G. Wheeler: Named director of engineering for Sheridan-Gray, Inc., Torrance, Calif.

C. W. (Jim) LaPierre: Retired from the General Electric Co., New York City, effective Aug. 1. He was the only executive vice president at GE and also a member of the Board of Directors. He was responsible for GE's entry into four of its major new businesses: jet engines, atomic energy, computers, and space.

Albert A. Sickeler: Elected to the Board of Directors of The Bethlehem Corp., Bethlehem, Pa. He is also vice president and general manager of the company.

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AUGUST

Thirteenth Annual Conference of Applications of X-ray Analysis, Metallurgy Div. of Denver Research Institute at the Univ. of Denver, Albany Hotel, Denver, Colo., Aug. 12-14.

Elementary Nuclear Magnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 17-19.

Tenth International Symposium on Combustion, Combustion Institute and Cambridge Physical Chemistry Dept., Cambridge Univ., Cambridge, England, Aug. 17-21.

International Astronomical Union Symposium No. 25, AFOSR, International Astronomical Union, Government of Greece, and Univ. of Thessaloniki, Thessaloniki, Greece, Aug. 17-22.

Ninth Annual Showing of Advanced Electronic Research Projects, sponsored by Stanford Electronics Laboratories, Stanford Univ., Stanford, Calif., Aug. 18-21.

Elementary Electron Paramagnetic Resonance Worksbop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 19-21.

Conference of Interference and Coherence, International Commission for Optics and Australian Academy of Sciences, Sydney, Australia, Aug. 24-25.

Nineteenth National Conference sponsored by Association for Computing Machinery, Sheraton Hotel, Philadelphia, Aug. 25-27.

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, Aug. 24-26.

Fourth Congress of the International Council of the Aeronautical Sciences, International Council of the Aeronautical Sciences and AIAA, Paris, Aug. 24-28.

"Graphic Techniques for Computation," sponsored by the Univ. of California Extension Center, San Francisco, Aug. 24-Sept. 4.

"Nuclear Education in the New Era of Nuclear Power," sponsored by Oak Ridge National Laboratory, Oak Ridge Institute of Nuclear Studies and U.S. Atomic Energy Commission, Div. of Nuclear Education and Training, Gatlinburg, Tenn., Aug. 25-28.

1964 International Congress for Logic, Methodology and Philosophy of Science, and International Colloquium on Algebraic Linguistics and Automata Theory, sponsored by AFOSR, AFCRL, ONR, ARO, and International Union for History and Philosophy of Science, Hebrew Univ., Jerusalem, Aug. 25-Sept. 2.



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The Lone Ranger

THE MAGNIFICENT SUCCESS of *Ranger VII* is fourfold—scientific, technological, administrative and political.

Everyone at Jet Propulsion Laboratory connected with this complex achievement deserves the warmest congratulations, from Director Dr. William Pickering right down to the lowliest member of the project team.

Also to be commended is the flawless transmission from the TV system developed by RCA's Astro-Electronics Division, the by-now routine success of the General Dynamics/Astronautics *Atlas D* launch vehicle, and the precision performance of the Lockheed *Agena* spacecraft.

A particular pat on the back is deserved by those in the guidance and control area of the system—including General Electric and Burroughs, Nortronics, Honeywell, Bell Telephone Labs, JPL itself, and others.

To name even these few is to do injustice to others of the more than 1,200 industrial firms which contributed to the *Ranger VII* performance. These range from such California firms as Ampex (video tape recorder) and Rantec Corp. (directional couplers) to Minnesota's G. T. Schjeldahl Co. (thermo shield) and New York's Conax Corp. (midcourse propulsion explosive squibs).

And how could anyone fail to mention the aptly named Ace of Space, Inc. (spacecraft electronic chassis), right in JPL's Pasadena backyard?

The staggering significance of the accomplishment has overshadowed 12 failures to obtain lunar data, six *Ranger* failures, a three-year lag in the program, some incredible mismanagement and months of frustration and investigation. In every sense of the word, it has been worth it.

The scientific gains alone boggle the imagination. Mission objectives for the Block III *Ranger* flights called for lunar photographs at least an order of magnitude better in resolution than any available Earth-based photography. The National Aeronautics and Space Administration reports that resolution was, in fact, 2,000 times greater than with Earth-based telescopes.

Man has learned more about the Moon's surface than ever before in his history. It is now believed that the dust layer, once considered as a possible major obstacle to a manned landing, is from one to two inches in depth. The surface appears something like crunchy snow, perhaps with the consistency of a biscuit, at least in the area photographed in the close-ups.

Analysis of the photos will continue for months. Initially, the existence of tiny sharp-edged craters in the photographs was taken to indicate the existence of small sharp-edged primary craters on the Moon. This in turn was taken to mean that the Moon's surface was hard, since sharp-edged craters would not appear in soft material.

Further analysis and re-thinking led to a different conclusion. Since any crater photographed as a very small object at the limit of resolution will look sharp, the existence of small sharp-edged craters can only be assumed if they are photographed close-up and still appear sharp-edged when they occupy a fairly large part of the picture. There are no craters of this type in the 60-by-100-ft. region of the Moon shown in *Ranger's* last picture (p. 22).

There may be small sharp-edged craters in other parts of the lunar surface. But the present set of photographs gives no indication of the existence of small sharp-edged craters of the order of three feet in diameter. Thus, the thinking goes, it is not proven that the surface is hard. It seems apparent, however, that its bearing strength easily will support the Lunar Excursion Module of the *Apollo* spacecraft.

Apollo Project Manager Dr. Joseph F. Shea says analysis of the photos indicates the bearing strength to be greater than the design assumption made for LEM. Grumman reports that not even minor modifications in LEM are contemplated as a result of the *Ranger* mission.

This confirmation of *Apollo* design assumptions has tremendous technological impact for the manned lunar-landing project. It means it can move ahead on schedule in the confidence that planning has been on the right track.

The technology and objectives of *Surveyor* and *Lunar Orbiter* now should be closely reviewed with the results of the *Ranger* probe in mind. To weight down *Surveyor* with scientific experiments which will merely bring further confirmation of the *Ranger* data is unnecessary. Nor should *Surveyor* make any ambitious attempt to obtain data not absolutely needed for *Apollo*. To increase its complexity in an effort to obtain data for purely scientific purposes which can be obtained by man himself a short time-span later is to uselessly hinder its chances for success.

IN THE ADMINISTRATIVE SENSE, the success of this one *Ranger* shot when stacked against the six previous failures confirms, contrary to much popular opinion, the extensive investigation of the program not only by Congress but by NASA and JPL itself.

Considerable credit must be given to the Karth subcommittee, to Dr. Albert Kelley and his early report on *Ranger* difficulties, to Mr. Earl D. Hilburn, Chairman of the *Ranger VI* Review Board, and to Mr. Herman LeGow of Goddard Space Flight Center, Mr. Francis Smith of Langley Research Center, Dr. Walter Jacobowski of the Office of Space Science and Applications and Mr. Eugene Dangle, Office of Program Review—all members of that review board. The extensive in-house reviews conducted by JPL itself also played a major role. The investigations did much to assure the success of this flight.

Politically, with NASA's budget predictably under fire in a period when the schedule provides little in the way of dramatic accomplishment, the success of this lone *Ranger* is a major boost for the entire U.S. space program.

William J. Coughlin

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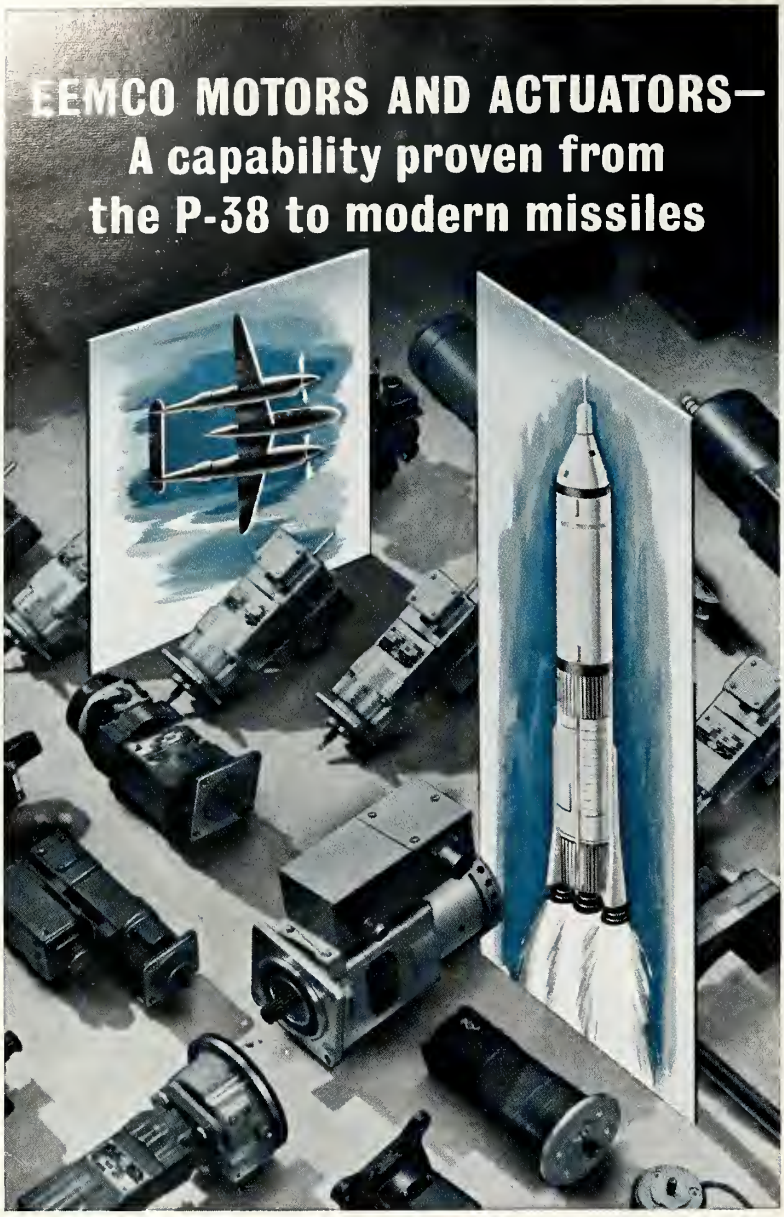
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missiles and rockets

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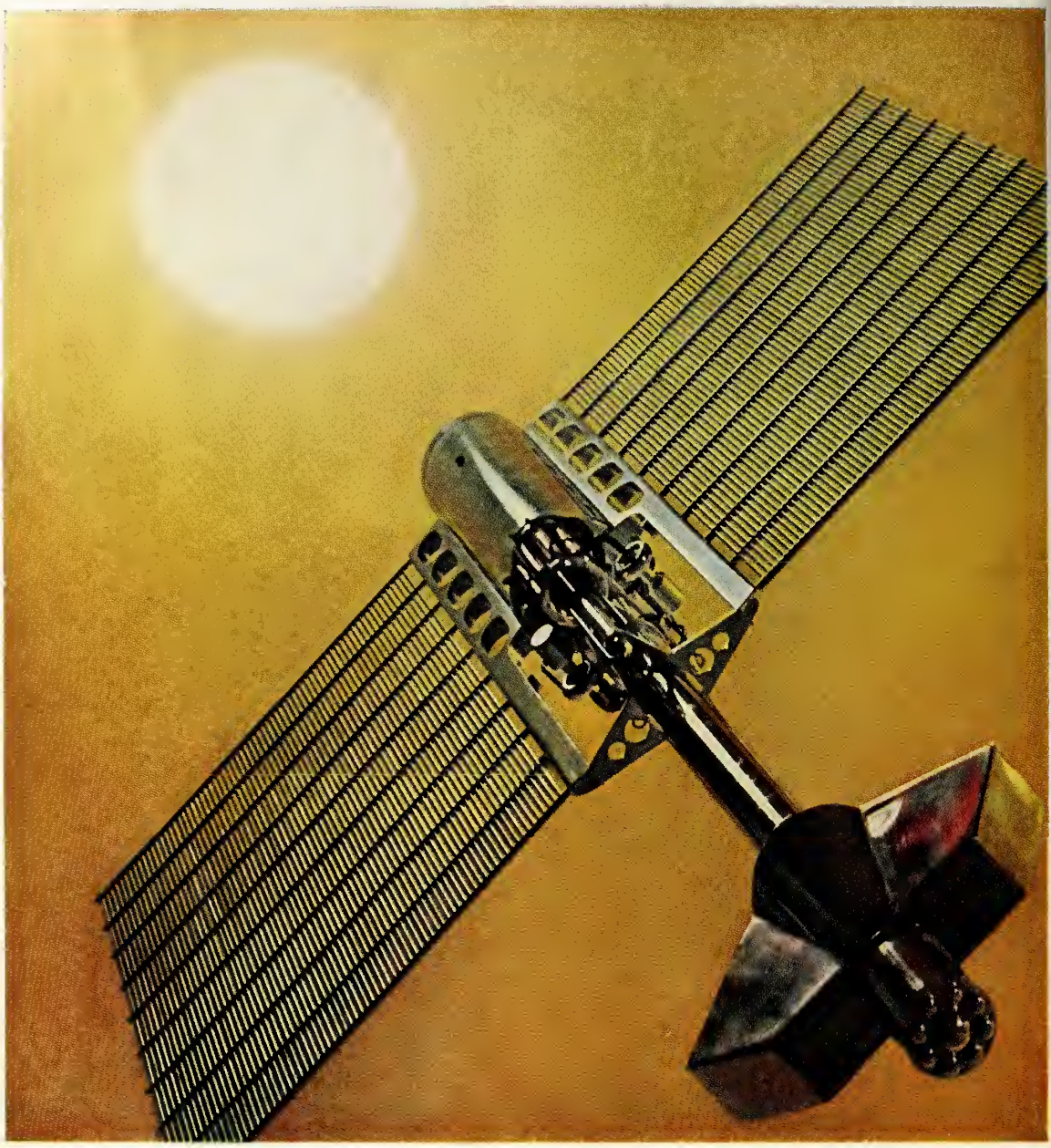
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First Closeup of TAD



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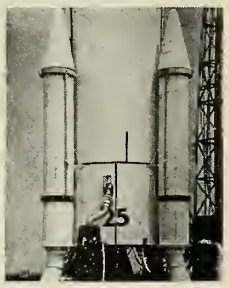
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THE COVER

First closeup photo of base of Douglas Thrust-Augmented Delta with Thiokol strap-on solid motors. TAD will be used for first time in launch of Syncom C. (See story, p. 11.) Launch is scheduled for Aug. 18. If successful, Syncom C will be used to transmit TV coverage of Tokyo Olympic games.

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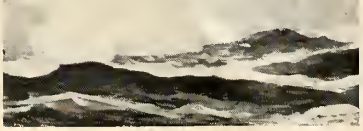
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Steam vs. Liquid Metal

To the Editor:

Your interesting article on the startup of a potassium vapor turbine (M/R, Aug. 3, p. 23) contains a paragraph reading: "Liquid metals were originally chosen over steam because the properties of materials such as potassium are such that a 1,600-1,800°F potassium vapor pressure remains under 100 psi. Steam at equivalent temperatures would exert up to 3,000 psi pressure."

This is quite misleading, since it inverts the true situation. The facts are that steam space power systems can be weight-competitive *without* operating at the high temperatures of liquid-metal systems; this is a major advantage.

The reasons steam systems can be weight-competitive are that water has a lower specific volume, a higher heat of vaporization, and gives higher system efficiencies, when used in the proper cycle. (See cycle, for example, in "Steam Concept interests Air Force" [M/R, April 27, p. 24.]) These cycles use pressures considerably less than 3,000 lbs./in.^{2}.

The effect on turbine design can be indicated by a specific example. Instead of the 8-in.-dia. inlet line mentioned for the potassium turbine, a steam turbine would require an inlet line less than two inches in diameter. The size ratios of inlet lines are even more striking. (It is this fact that makes water-condensing radiators weight-competitive, despite larger fin areas.)

From the lower system temperatures stem the advantages of no auxiliary cooling loops, and of greater reliability (see curve on page 14 of the AEC's official "Evaluation of Systems for Nuclear Auxiliary Power," TID 20079). It is also obvious that lower temperatures mean easier development.

We respect the abilities of engineers who can work on the frontiers of a technology and make a workable piece of machinery. Our philosophy, however, is "why work hard to meet mission requirements if you can do it an easier way?" We note that the turbine being tested was started up and, later, "motored" with a steam turbine. When, at some future date, we read that a steam turbine has been started up and motored with a liquid-metal turbine, we will know that liquid-metal technology has really arrived.

J. Frank Coneybear
President, ASTRA, Inc.
Raleigh, N.C.

Odds Getting Better

To the Editor:

In these days of charge and countercharge regarding the reliability of this or that aspect of our space program, I for one get pretty confused. It's difficult to determine just whom, and what facts presented in our news media, one should believe. So, I decided to make my own assessment.

First, I'm interested in the reliability of the overall space program (both large and small payloads, simple and complex systems), not just one particular part of it. Second, I'm willing to assume that the launches are independent of one another and that each launch has the same probability of success in a given year. This assumption would allow me to determine (via the binomial distribution) the probability corresponding to some number of successful flights out of the total number of attempts if I knew the value of p, the probability of success. Now, the value of p is measured by the success of each space vehicle involved in the program. Thus, I needed an objective, unbiased tabulation of successes and failures of U.S. space vehicles since the inception of the program. Well, fortunately for me, TRW Space Technology Laboratories recently published such a list on page 50 of their Space Log, Vol. 4, No. 1, dated Spring, 1964.

Now, I'm also interested in what the chances for success were at the beginning, what they are now, and what I expect them to be in the near future. Thus, I'm really concerned with reliability growth, or how the value of p has changed since the start of the program. How can I determine this growth? Well, one easy way is to divide the number of successes by the total number of tries on a yearly basis and plot these points on a graph of Probability of Success versus years. The chances of failure can also be represented in a similar manner.

By themselves, these discrete elements don't provide much information, so a way of combining them all is required. Points on the graph might be samples drawn from an exponential population, but some additional evidence would be required before such a statement could be made, especially to a statistician. Well, again fortunately for me, Dr. S. Shapiro of GE's Advanced Technology Laboratory provided the answer in the form of a test which can be applied to check just such an assumption. The results of his test indicate that I can be at least 95% confident that these 8 samples of the yearly probability of failure were taken from a parent population of the exponential form . . .

Now what does all of this tell me about the chances for success of our space program? Well, for one it says that our initial chances were pretty slim. The results in 1957-8 verify this. Secondly, this year our probability of success has reached 90%; so far we're doing better. Next year our chances of success ought to be about 93%. By 1971 we ought to be in the neighborhood of 99% successful.

Ernest W. Sherman
General Electric Company
P.O. Box 2500
Daytona Beach, Fla.

Reader Sherman's letter was accompanied by two graphs and a set of formulae. Unfortunately, space limitations in these columns made it impossible to reproduce them. We suggest that those interested contact Mr. Sherman at the above address.
—Ed.



Launch Systems opportunities at Boeing

Boeing's Launch Systems Branch, a major contractor on NASA's Saturn V program, has a number of exceptional openings for qualified engineers and scientists. These assignments offer you the unique growth advantages of a rapidly expanding, long-range program, and the professional prestige of association with one of the world's major space efforts.

Openings are available in New Orleans, La. and Huntsville, Ala. for specialists in the following areas: systems engineering, simulation systems, ground systems, flight technology, electronics technology, electronic/electromechanical parts development, hydraulics, structures, instrumentation, metallurgy, dynamic stability, production testing, aerospace program planning, reliability and quality assurance, tool design and production tool planning, scientific computer programming, and operations management.

Salaries are commensurate with all levels of education and experience. All openings require a B.S. or advanced degree in engineering or physics, and applicable work experience. Boeing pays travel and moving allowances to newly hired personnel. Boeing is an equal opportunity employer.

Advance your career with the Saturn V program at Boeing. Take a moment now to send your resume to Mr. L. Wendell Hays, The Boeing Company, P. O. Box 26088-MSU, New Orleans, La. 70126, or Mr. Farrell Desselle, The Boeing Company, P.O. Box 1680-MSU, Huntsville, Alabama.

BOEING

AERO-SPACE DIVISION

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At Spring Joint Computer Conference 3C introduced DDP-224, faster than the DDP-24. Multi-processor options were also announced. At the same time a Van-Mounted DDP was unveiled. Prices on the 24 were reduced May 1 to reflect production economies. With this advertisement, 3C announces the DDP-24A (modified I/O capabilities) and previews the DDP-24P, portable version of the 24, small enough to pass through submarine hatches. Extensive software and user services are basic to all models. Write for complete details.



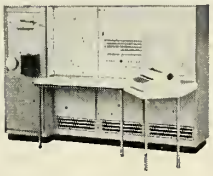
DDP-224
New 24-bit word DDP-224 features: 1.9 μsecs (0.8 access) memory cycle, and powerful command structure, 260,000 computations per second. Transfer rates up to 325,000 words per second. 3.8 μsecs add. 6.46 μsecs multiply. 17 μsecs divide. 4096-word memory expandable to 32,768. Typical add time with optional floating point hardware 7.6 μsecs (24-bit mantissa, 9-bit characteristic). Fully program compatible with DDP-24.

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DDP-224 MULTI-PROCESSOR
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DDP-24 VM
The Van Mounted DDP-24 is a rugged, compact, fully mobile general purpose digital computer; functionally identical to the 24 with paper tape reader, punch, and specially mounted I/O typewriter.

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The Countdown

WASHINGTON

Next Ranger Launch May Be in February

NASA is studying February as a favorable launch time for *Ranger VIII*. This would permit a lunar impact closer to the Moon's Terminator—the line between daylight and darkness. Manned Spacecraft Center officials want the launch timed so that the Sun angle on the lunar target area is less than 10 degrees. Says one: "That's where the numbers really start to count. If we know what portion of the surface is under 10 degrees in slope and what portion is over, we will have a much clearer idea of the probability of a successful landing by a lunar vehicle."

Technical Troubles Plague Surveyor

Surveyor has run into technical snags. Major problem at the moment: the vernier soft-landing stabilization system. A NASA spokesman describes the problem simply: "It just won't work." NASA hopes to solve the problem in time to have the first engineering model of the soft-landing lunar craft ready for launch in the last half of 1965. *Surveyor* troubles have forced some slippage in the *Centaur* launch vehicle development program. *Centaurs 4* and *5* still are scheduled for launch this year. *Centaur 6* will be launched in the first half of next year with *Centaur 7* as the vehicle scheduled to lift the first *Surveyor* engineering model. Under the present pace of the program—with future delays probable—the first *Surveyor* soft-landing on the Moon might not come until late in 1966.

Para-sail Selected for Gemini

Use of a paraglider system had been pretty well ruled out in the *Gemini* program, but the Aug. 7 crash at Edwards AFB (see p. 14) was the crusher. Manned Spacecraft Center has just awarded Pioneer Parachute Co. a $246,358 contract for 26 drops of the para-sail to complete its development. According to the contract, the para-sail will be used to recover *Gemini* and other similar weight spacecraft.

TAD Set for First of Five

Launch of *Syncom C* by the *Thrust-Augmented Delta* booster, set for this week, will be the first of five missions for the launch vehicle over the next 12 months. Future missions include two *Interplanetary Monitoring Platforms (IMP)* and two launches of the new *Tiros* "cartwheel" configuration weather satellite.

Grissom To Make First Gemini Maneuver

First attempt to maneuver the *Gemini* spacecraft will come on the *GT-3* flight when Maj. Virgil "Gus" Grissom will attempt a change in plane. Maneuver will be made near the end of the second orbit while the spacecraft is passing over Hawaii.

MSC Ready for One by February

Manned Spaceflight Control Center at the Manned Spacecraft Center in Houston is to have a one-vehicle control capability by Jan. 31. Dual vehicle capability—both *Gemini* and *Agena*—is expected by May 31.

Genie Air Launch Set Back by Crash

Project at Kirtland AFB for air launch of a *Genie* high-altitude probe was set back a month by the recent accident to the B-57-B mother ship, which suffered a collapsed landing gear on take-off. Incidentally, the aircraft—dubbed "Pinocchio" because of an elongated nose—was the test vehicle in the *Bomarc* project and was resurrected from the boneyard for the current tests.

NASA To Reveal More Ranger Details

Results of further analysis of the *Ranger* lunar photos are to be released by NASA in a press conference about a month from now. Meanwhile, NASA is putting the 4,316 photographs into a 16-mm motion picture. The film will give a "motion picture effect" of the Ranger descent to the lunar surface, but NASA officials have declined comment on speculation that it will be used to prepare astronauts for the *Apollo* landing mission.

INDUSTRY

GE Wins Tracking Contract over Motorola

NASA surprised industry observers with award to General Electric of a contract for one, and possibly two, Goddard Range and Range Rate (GDDR) tracking system. Fixed-price contract for a station at Fairbanks, Alaska, is expected to total some $2.3 million. Contract will inclinclude an option for a second station, to be located at Santiago, Chile. Motorola built three earlier stations and was regarded as the leading contender for this contract.

Navy Picks Seven for ASMS Study

Navy has tagged seven firms for pre-project definition studies of the *Advanced Surface Missile System (ASMS)* designed as a replacement for the current family of T-Missiles aboard naval ships. Awards are for $500,000 each. They go to Raytheon, Boeing, Sperry Rand, General Electric, Westinghouse Electric, Radio Corp. of America, and Hughes Aircraft.

Marshall Invites Support Bids

Marshall Space Flight Center has invited 34 firms to submit bids by Sept. 23 for a support contract for the Facilities and Design Office. RFP's also have been sent to the same firms for a support contract for the Quality Assurance and Reliability Laboratory. Bids are due Sept. 25.

AFSC Evaluates Standardized Guidance Bids

Evaluation of proposals from four contractor teams on a standardized space guidance system is under way at the Air Force Systems Command's Space Systems Division. Recommendations are to be forwarded to Dept. of Defense next month. Teams are headed by IBM, TRW Space Technology Laboratories, Sperry Gyroscope and North American Aviation.

INTERNATIONAL

Canada Ready to Sign Comsat Pact

Canada has announced it will sign the documents incorporating the international agrcement on a global satellite communications system when they are opened for signature in Washington this week. It will be among the first nations to do so.

NASA To Receive $5.25B

NASA has received a final total of $5.25 billion from Congress.

House and Senate conferees arrived at a total that in effect cut $50 million from the Senate figure for research and development. Otherwise the Senate figure prevailed.

The conferees voted $4,363,594,000 for research and development; $262,880,500 for construction; and $623,525,500 for administrative operations. The two latter figures were the total amounts authorized in those categories.

NASA asked the appropriations committees for the total authorization of $5,227,506,000, plus $141 million in supplemental funds for Fiscal Year 1964. This brought the total request to $5.368 billion. The Senate Appropriations Committee cut $68 million from this, leaving the Senate amount at $5.3 billion.

In spite of the fact that the House conferees were not bound by this figure out of a technicality by which the House was not allowed to act on NASA funds, the conferees did use it as a guideline. Thus the $100-million difference in the two amounts was split evenly.

Schriever Views Future

Air Force Systems Command chief Gen. Bernard A. Schriever has warned against the temptation to relax after the achievements of the ICBM program.

Schriever told the Ninth Symposium on Ballistic Missile and Space Technology in San Diego, Calif., there are a number of possible breakthroughs that would give the Soviets decided advantages over the United States. An obvious example is the development of an effective defense against ballistic missiles.

In a press conference, he conceded that the only technologically feasible approach to the development of such a system for the U.S. is represented by the *Nike-X*, but he noted that such a point defense system cannot be effective without a national fall-out shelter program.

Schriever characterized space weapons, perhaps involving lasers, as possible, "but still in the 'blue sky' phase . . . we can't plan on them." Areas of technological opportunity identified by Project Forecast includes materials, propulsion, flight dynamics, guidance and computer technology, he said. Materials were cited as perhaps the most promising area.

Teller Hits LASV Decision

Dr. Edward Teller has termed cancellation of the *Low Altitude Supersonic Vehicle (LASV)* as the ". . . biggest mistake we have made since the years following the war when we failed to develop the ICBM."

In an off-the-cuff talk before students of the Air Force Institute of Technology at Wright-Patterson AFB, Ohio, the outspoken nuclear scientist described the missile as "insurance" that was killed by cost/effectiveness studies.

He contended that the vehicle was the "proper weapon system to penetrate Russian defenses" and noted that savings from its cancellation amounted to less than 1% of the Air Force budget.

Not only is the U.S. failing to develop the necessary effective low altitude offense missiles needed to insure military superiority for years to come, Teller said, but it also is not doing enough in developing defensive weapons that could diminish the effect of enemy missiles headed for American soil. "The great and important need is to provide a better defense, particularly because the ballistic missile defense is the one item that could affect the balance of power," he said.

Scout Upper Stage To UTC

A new solid propellant upper stage for the *Scout* launch vehicle will be developed, qualified and delivered by United Technology Center under a contract from the Air Force Space Systems Division.

The motor will have a glass-filament case and generate about 6,000 lbs. thrust.

Tracking Ship Gets New SINS

An improved Mark IV SINS, produced by Northrop Corp.'s Nortronics Div., is being installed aboard the Air Force Advanced Range Instrumentation Ship, USAFS Hoyt S. Vandenberg, (see item, p. 17), to provide precision stabilization of the ship's tracking radars.

The new SINS, to be installed aboard the Vandenberg at Baltimore, is a compact version of an earlier system designed in conjunction with the Massachusetts Institute of Technology. The early system was used in a one-year shipboard test on the Compass Island research vessel and is currently undergoing laboratory evaluation by Nortronics and MIT. It will later be re-installed for further testing.

Primary advantage of the Vandenberg SINS is its diminutive size compared to existing systems. The major components—navigation console and gimbal assembly—fit through normal shipboard hatches and watertight compartment doors without disassembly. The entire working system is only one-fifth the volume and one-third the weight of present operational systems aboard *Polaris* submarines.

The navigation console provides position, heading and speed indicators and transmits these data to other shipboard systems.

120-in. Firing Successful

The recent test firing of the *Titan III-C* 120-in. solid booster—the fourth in the series—was termed an absolute success by Space Systems Div. Deputy Chief of Staff for Manned Spaceflight Brig. Gen. Joseph Bleymaier.

A joint failure in the nozzle skirt during the last ten seconds of the 112-second test marred the firing, but data were received from 300 instrumentation points and there was no damage to the motor casing.

United Technology Center President Barnet Adelman noted that the thrust-time curve was normal during the final seconds of the test. The failure will not affect the *Titan III-C* test program and did only minor damage to the Coyote, Calif. test stand.

All test objectives were met and the nozzle failure was not in the flight system.

Ocean-Launched Probes Slated

A series of sea-launched sounding rocket experiments will be handled by the Navy for Lawrence Radiation Laboratory in both the Atlantic and Pacific Oceans.

The research rocket, consisting of the U.S. Naval Missile Center's *MR-1* booster and Atlantic Research Corp.'s *Iris* motor, will be launched from a vertical floating pad. Ignition of the three booster motors and the *Iris* occurs simultaneously in the submerged condition. The *Iris* is held in place atop the *MR-1* by the combined

effect of the aerodynamic and mechanical alignment between the two stages and the excess thrust of the *MR-1*.

Booster thrust decay allows the *Iris* exhaust to push it away and the upper stage and payload continue the rest of the flight.

A *Hydra-Iris* probe will be launched at a site some 400 mi. west of Point Mugu in September. A second probe will be launched from the geomagnetic equator in October and a third from the Gulf of Alaska next spring. All are designed to measure the rate of change in neutron density in relation to altitude.

Shots of the Week

The Air Force fired a *Titan II* ICBM from an underground silo at Vandenberg AFB, Calif., Aug. 11. Thrust of the liquid propellant fuel was 430,000 lbs. All subsystems operated successfully, according to the Air Force, and preliminary data indicated complete success.

- The *X-15* rocket plane scored a success Aug. 12 with a flight from Edwards AFB, Calif. Pilot Milton O. Thompson flew the aircraft to an altitude of 81,000 ft. and a maximum speed of 3,511 mph. It was the 113th flight for an *X-15*.
- The Air Force on Aug. 5 launched a secret satellite toward polar orbit. The launch from Vandenberg AFB used a *Thor-Agena* combination. The satellite was presumed to be similar to the *Discoverer* series.
- The Navy successfully launched a 2,800-mi.-range *Polaris A-3* Aug. 7 from the submarine Tecumseh, submerged 30 miles east of Cape Kennedy.
- Scientists from the University of Michigan and Michigan Tech launched as *Arcas* weather rocket from Copper Harbor, Mich., Aug. 6. The rocket, which reached a peak altitude of 220,000 ft., "performed perfectly," a spokesman said.

Nimbus Launch Slips

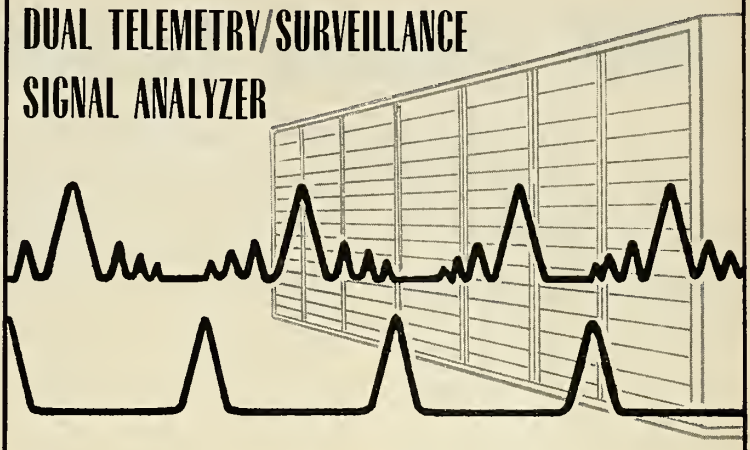
Launch of the first *Nimbus* weather satellite has been postponed until Aug. 28 at the earliest because of a faulty relay box in the second-stage *Agena-B* launch vehicle.

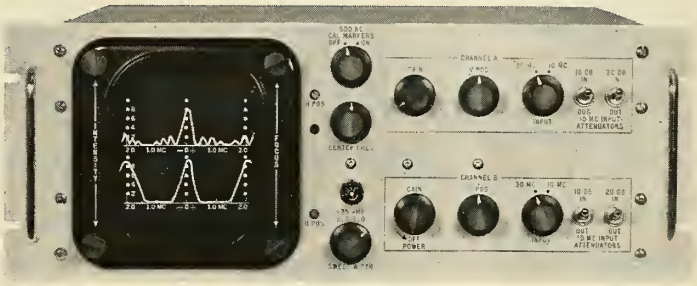
The NASA satellite and the *Agena* stage will have to be demounted and separated for replacement of the box.

The fault was discovered in the final checkout of the 830-lb. satellite, scheduled for launch Aug. 14 after a two-year delay in schedule.

WATCH DEI

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The latest in DEI's SA display series, the SA-101 also provides greater sweep width . . . from 0 to 4 mc; with better resolution . . . 10 kc; larger and brighter display; and bigger . . . five-inch dual gun . . . CRT with calibration markers. The 2-in-1 display package also saves precious ground station telemetry receiving system space—yet is versatile enough for connection to ordinary oscilloscopes for remote displays.

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In FY '65, $2 million . . .

ERC Awards To Begin Shortly

Out-of-house contracting level will climb to $42 million a year by FY '69; selection of permanent site awaits Webb's return

by Hal Taylor

NASA'S NEW Electronics Research Center in Boston will award its first contracts to industry in two to three months.

Dr. Albert J. Kelly, deputy director of the new Center, told MISSILES AND ROCKETS that while there are some administrative procedures to wade through, "we are gearing up to get started as fast as we can. The first out-of-house contract should be made in two or three months."

Kelly made the comment as the space agency announced that the Electronics Research Task Group will move to Boston about Sept. 1 to begin establishment of the Center. The 30-man task group—together with NASA's 50-man Northeastern Operations Office which it will assimilate—will be located at 30 Memorial Drive, Cambridge, Mass. It will remain there until mid-October, when it will move to 575 Technology Square in Cambridge.

Total Fiscal 1965 contracting with industry, according to the master plan drawn up by the Center, will total only $2 million. NASA officials report that the major effort in the early part of FY '65 will be in research contracts for the development of electronic components for space applications. There will also be a heavy effort in the area of space optical communications including lasers. Later, the emphasis will shift to studies of components able to resist high temperatures and radiation, instrumentation and data processing and new microwave and guidance systems.

In FY '65 plans call for total out-of-house contracting of $7.5 million. In FY '67 the level is expected to grow to $14 million. Other planned contracting levels are $26 million in FY '68 and $42 million in FY '69.

● **Leadership**—Contracting work will be handled by the Procurement Office of the Northeastern Operations Office, which is headed by Franklyn W. Phillips.

Administrative duties will be handled by a staff composed of Joyce Killam, Alexander R. Lawrence, Dana W. Murphy, Wendell H. Pigman, Patrick J. Croall, Michael A. Nigro, R. E. Wright, and Donald Toohey.

Making up the first scientific echelon will be Richard Hayes, Ernest Steele, Frank Holmstrom, Gilmore Trafford, John Sullivan, Max Nagel, Seymour Schwartz, James Cline, Gene Mannela, Eugene Darling and Anthony J. Calio.

The Center will be headed by Dr. Winston E. Kock, formerly vice president of research, Bendix Corp., Detroit. He will assume his duties as director on Sept. 1.

Selection of a permanent site for the new Center probably will have to wait until late this month at the earliest. NASA Administrator James E. Webb will be on leave until Aug. 24, and no announcement of the site is expected until he returns.

In the meantime, Center personnel are expected to occupy the Technology Square location for at least a year. It is expected that eventually these quarters may total as much as five floors of the building. While some laboratory space will be available, most of the in-house effort is expected to take place at the labs of the nearby Harvard University and MIT.

In-house effort—based on the master plan—is never slated to get very large in terms of money volume. It will total only $500,000 in FY '66, $4 million in FY '67, $4 million in FY '68 and $8 million in FY '69.

The highest budget of the Center will be $76.6 million by 1969. Over $34 million will cover operating and administrative expenditure. ■

Welsh Doubts That Any Big Defense Cuts Are Looming

A TOP ADMINISTRATION official foresees no substantial decrease in U.S. defense spending in the immediate future.

Dr. Edward C. Welsh, acting chairman of the National Aeronautics and Space Council, said that if conditions warrant such a decrease, "the most efficient and logical direction of a transfer of funds would be toward an expanding space program."

"It is my thesis that mutual disarmament—and prudence dictates that there should be no other kind—would greatly increase the flow of funds and effort in space exploration and into the building of greater space capability," Welsh declared.

In an address before the Aerospace Industries Association Council of Seattle, Washington, the official also made these statements:

● "Part of any decrease in the production of weapons systems should be offset by an increase in the research and development of advanced weapons technology. We must stay on the technological alert. All too often, the emotional impact of disarmament falls upon the fields of research and development rather than upon operational and obsolescing weapons systems where it belongs. Economies can properly be found in the discontinuance of systems and facilities no longer needed, but savings should not be sought from investments necessary for the development of new methods and new systems."

● "Space systems have peculiar advantages in the keeping of the peace. Hence, a trend away from weapons of aggression should be replaced with a trend toward systems of surveillance, detection, and interception from space."

● "Contrary to alarming reports, there is no depression in the space business. . . . The total spent on space by all agencies of the government in 1964 is more than six times what it was in 1960. This is a business which has moved in the last four years from a gross of less than $1 billion to more than $6 billion. . . . True, such a rate of increase is not going to continue, but assuming a favorable election this year, I would expect that the trend of space expenditures would be upward."

Launch due Aug. 18 . . .

NASA Prepares to Orbit Syncom C In Debut of Thrust-Augmented Delta

Truly synchronous orbit planned for modified communications satellite which may provide TV coverage of Tokyo Olympics

THE SPACE AGENCY this week will chalk up the first launch of its *Thrust-Augmented Delta* (*TAD*) booster in an attempt to place the *Syncom* communications satellite in a truly synchronous orbit around the Earth.

If successful, the satellite will be used to telecast back to the U.S. the 1964 Olympic games, which will be held in Tokyo.

The launch of *Syncom C* is scheduled for no earlier than Aug. 18. After two eccentric orbits, the spacecraft will be moved into a truly stationary equatorial orbit at a point above the International Date Line.

The *TAD* launch vehicle—which will later be used to boost NASA's *Biosatellite* and *Advanced Technological Satellite*—has a first-stage thrust of 333,550 lbs., compared to the 172,000 lbs. of the standard *Delta* vehicle.

The sharp increase is achieved through the use of three Thiokol Chemical Corp. solid-rocket motors strapped on the modified Douglas Aircraft Co. *Thor* first stage.

Each of the motors are 31 in. in dia. and 237.44 in. high. With a total weight of 9,170 lbs., each motor's 7,238 lbs. of propellant produces a thrust of 53,850 lbs.

TAD also ultilizes the improved Allegany Ballistic Laboratory X-258 solid rocket third stage with a thrust of 5,700 lbs., compared to only 3,000 lbs. of thrust for the previously used X-248 third stage. The additional thrust is just enough, the space agency said, to put *Syncom C* into a stationary orbit.

TAD's second stage is a liquid powered Aerojet-General Corp. JA-118 propulsion system with a thrust of 7,500 lbs.

Total weight of the booster at liftoff will be 71 tons. It will be 90 ft. tall, with a maximum diameter of eight feet.

Earlier satellites in the *Syncom* series were launched on Feb. 14 and July 26, 1963. *Syncom I* achieved synchronous orbit but all communications ceased about 20 seconds after its apogee kick motor was fired. *Syncom II* also achieved synchronous orbit and has been in continuous operation since then.

• **Changes**—*Syncom C* will be closely similar to its two predecessors, although it will have several important differences. It will also be cylindrical, 28 in. in diameter with a height of 15½ in. and a total weight of 148 lbs.

One change from the earlier satellites will be the use of new n-on-p solar cells, which are more resistant to radiation than p-on-n cells used previously. *Syncom C* will also have two hydrogen-peroxide jet control systems, rather than the hydrogen-peroxide and nitrogen systems utilized on *Syncom I* and *II*. The latest satellite also lacks a timer for preset firing of the apogee kick motor and can be fired by ground command only. Finally, *Syncom C* will have one 5-mc transmitter-receiver unit and one 13-mc unit for television transmission. *Syncom II* has two transmitter-receiver units of dual 500-kc and 5-mc bandwidths respectively.

When the satellite reaches stationary orbit, it will be able to communicate with ground stations located at Clark Air Force Base in the Philippines, a station at Guam and one at Camp Roberts, Calif.

Japan currently is building a station to transmit the 1964 Olympics to this country and an antenna at the U.S. Navy's Point Mugu, Calif., facility is being modified to receive the transmission. ■

Council Calls for U.S. Military Space Domain

THE UNITED STATES must develop without delay a military capacity in the 100-500-mi. sphere surrounding the Earth "to extend and preserve a deterrent strength or control or inhibit those who would use their power aggressively to dominate life on Earth." This is one of the conclusions of the 128-page study of the American Security Council's National Strategy Committee.

The Council, a privately financed organization, also favors a NATO nuclear deterrent independent of, but coordinated with, the U.S. strategic force; maintenance of the Strategic Air Command as a mixed-bomber force to preserve "the enormous firepower of the bomber and maintenance of overall U.S. military superiority through rapid technological progress and modernization; the building of a supreme, flexible, effective strategic force; the "invasion-proofing" of Europe by arming NATO with tactical nuclear weapons; and the development of the antimissile missile and community fallout shelters.

Chairing the committee was Robert M. Galvin, chairman and chief executive of Motorola, Inc. Other members included Admiral Felix B. Stump (USN, ret.); Edward Teller, nuclear physicist; Gen. Mark Clark (USA, ret.) and Gen. Robert E. Wood (USA, ret.) The report also dealt with Cuba, Southeast Asia, foreign aid and an effective economic offensive against Red countries.

Campaign issue? . . .

Goldwater, Pentagon Clash on Defense

GOP nominee warns of potential loss of 90% of 'deliverable nuclear capability'; DOD counters that charge is 'totally false'

by James Trainor

SEN. BARRY GOLDWATER (R-Ariz.) and the Dept. of Defense have already swapped charges in what promises to be one of the major issues in the 1964 Presidential campaign—defense policies of the Kennedy-Johnson Administration.

"Sometime in the decade ahead, unless present plans are changed by the demand of an aroused public," the Republican presidential nominee told a meeting of the National Association of Counties last week, "America's deliverable nuclear capability may be cut by 90%."

"Not only without foundation but contrary to the facts," the Defense Department replied in a statement released through Arthur Sylvester, Assistant Secretary for Public Affairs. Release of the statement by Sylvester, rather than by Secretary of Defense Robert S. McNamara, was interpreted as a ploy to belittle, or at least not to dignify, the Senator's allegation by a top-level answer.

● **Peace through preparedness**—Reviving the traditional shibboleth that "this nation has gone to war under only one party," Goldwater asserted that "in my campaign across this nation I can hope to sound no more clear message than that of peace through preparedness."

Among the areas in which the Arizona conservative feels that U.S. is "dropping our guard" were:

—"Our R&D program has increased by less than 15% in each of the past three years and by only close to 10% this year."

—"We face the prospect of going into the decade of the 1970's without a single new manned bomber."

—"We face the prospect of going into that decade with a worn and obsolete force composed only of those left-over planes still able to fly."

—"At worst we could find ourselves in the 1970's without a single one of the flexible, manned weapons which give us the vital scale of a controlled, graduated deterrent rather than only a capacity for all-out, intercontinental nuclear confrontation."

—"Our appropriations for strategic deterrent forces of all sorts have been declining steadily. In the current fiscal year they are hardly half of what they were three fiscal years ago."

Goldwater also warned against what he termed "the public relations gimmick of parading versions of a single reconnaissance aircraft before the public and representing them as a whole series of new weapon systems." This was a reference to President Johnson's announcements of the A-11 supersonic airplane, which is being tested as an interceptor while, in another version, being acclaimed as a strategic reconnaissance aircraft.

● **"Totally false,"** says **DOD**—The rebuttal issued through Sylvester countered Goldwater's main argument by asserting that "by mid-1970 our missile force alone will contain more weapons on alert and as many megatons as did our entire bomber alert force in mid-1961."

"Therefore," the statement concluded, "it is totally false to state that 'our deliverable nuclear capacity may be cut down by 90% in the next decade.' The facts are that in 1970 we will have a capabiliy to deliver or target 2½ times as many warheads as we had in 1961 and a greater number than we have today."

Noting the importance of survivability and penetrability to a strategic deterrent force, the statement asserted that the Administration since 1961 has taken "drastic measures" to improve our forces in both of these areas.

When the Kennedy Administration assumed power in 1961, it noted, almost all the strategic retaliatory force was in bombers that were soft, concentrated and maintained on a relatively low level of alert. Also, "we had only five ICBM's, all based above ground and concentrated, and we had only two *Polaris* submarines in the fleet.

Since that time, the statement continued, there has been a 150% increase in alert weapons and a 200% increase in alert megatons in our strategic retaliatory forces. "But more important than the increase in total strength is the fact that we have replaced a vulnerable force relying almost solely on bombers with a balanced force including a very large number of protected missiles which we can count on to survive and penetrate to their targets."

"Between now and 1970 we will continue these improvements. Already we have budgeted for 400 more *Minuteman* missiles for a total of 1,000 and we are building to a total of 41 *Polaris* submarines containing 656 missiles." The reference to 400 more *Minutemen* is to the fact that 600 are now operational. In addition, the present force structure contains more than 200 *Atlas* and *Titan* ICBM's, 126 of which are based underground in hardened and dispersed silos. To the original two-boat submarine force, 14 more *Polaris* subs have been added and this force is increasing by one per month. ■

Correction

ON PAGE 22 of M/R, Aug. 10, the final page of *Ranger VII* photos, the captions are in error. The first caption actually refers to the partially cropped photo at the bottom of the page. The second caption relates to the final *Ranger VII* shot, reproduced immediately under the middle of the page, which includes a receiver noise pattern to its right.

The picture reproduced at the top of the page, but not covered by the caption, was taken by the F-a camera with a 25-mm, f/1 lens 2.3 sec. before impact, at an altitude of about three miles. It shows an area about 1⅔ mi. on a side. with smallest visible craters approximately 30 ft. in diameter and 10 ft. deep. Among the many craters with rounded shoulders one is prominent in upper left of the photo. About 300 ft. in diameter, it has a conspicuous rock mass in its center which NASA scientists believe might have come from Copernicus.

Due to erroneous early information from NASA, the figures given on page 21 for crater diameters are incorrect. In the top photo on that page, diameter of the smallest visible craters is 150 ft. In the bottom photo, the smallest craters shown are estimated to be 45 ft. in diameter.

Despite breakoff of talks . . .

DOD-ComSat Agreement Still Possible

Fubini outlines interim Pentagon program of Philco-built satellites hitchhiking on Titan III's; pricetag would be about $20 million

by Heather M. David

WHILE THE DEPT. of Defense has stopped negotiating with the Communications Satellite Corporation for the military satellite system at this time, ComSat Corp. apparently is still in the running to do business with DOD.

ComSat President Joseph V. Charyk told a House Military Operations subcommittee that the Corporation would be ready to do one of two things:

—Build a separate satellite system for DOD, in which ComSat Corp would put up the capital, take the risks and sell the service.

The satellites could be launched on separate or common boosters with the commercial venture.

—Act as service managers to a system built by DOD.

Rep. Chet Holifield (D-Calif.), chairman of the subcommittee which has been investigating the whole problem of the military communications satellite program for a number of months, told MISSILES AND ROCKETS "the door is wide open" for some future arrangement between DOD and CSC and that it seemed feasible as long as DOD could be assured of a separate system responsive to military needs.

Charyk told the subcommittee that the problems which caused the DOD to pull out of the proposed system, in which the satellites would be shared with commercial users, would not be present in a separate system. While CSC is a 60% partner in the international venture, its agreement to cooperate in an international communications system does not affect in any way any other activities the corporation may wish to engage in unilaterally, Charyk indicated. The Corporation in fact could build military systems for foreign countries, as well.

● **DOD testimony**—Assistant Secretary of Defense and Deputy Director of Defense Research & Engineering Eugene G. Fubini told the committee that the proposal "might be interesting when the time comes," although it would require a change in circumstances to bring it about.

The Dept. of Defense has meanwhile decided to launch its own system as an interim program awaiting some future, more advanced system. Fubini said that Philco Corp., "if it can meet the price" will be negotiated with to construct the satellites. This price is estimated at about $20 million, he indicated.

Eight satellites apiece will ride aboard as hitchhikers on the eleventh, twelfth and thirteenth development launches of the *Titan III-C* space booster. These satellites will be launched to an altitude of 18-19,000 mi. in random equatorial orbit. Fubini also indicated that if the first two launches of the satellites are successful, the third may be shelved in favor of other experiments which are seeking space on *Titan III*.

Only minor modifications will have to be made to the satellites, which otherwise will follow the design of those originally considered by DOD for a medium-altitude system to be launched by *Atlas-Agena*. These modifications will be to change the antenna for the higher altitude, some component changes for reliability, and fitting to the *Titan III*.

Fubini said that the two systems—24 satellites launched by the *Atlas-Agena* at 6,000 mi. and 16 launched by the *Titan III* at 18,000—are about comparable in their vulnerability to physical destruction and electronic jamming.

Economics and a possible wish to justify the *Titan III* booster appeared to be the reason for the switch. Fubini said that in the original medium-altitude plan it was determined by DOD that seven *Atlas-Agena* boosters would be needed, with six satellites apiece, to put a minimum of four groups into orbit. This would have cost approximately $91 million, he estimated. With the free rides on *Titan III*, the system will cost $20 million. Even if the cost of the *Titan III's* were attributed to the satellite program, the total would run roughly $62 million for this program, he said.

When questioned about the risk factor in using a booster still in development, Fubini estimated that after 10 *Titan III* launches, the overall probability of success for the next three would be 60%, with an 84% chance of one out of two, and a 90% chance of one out of three.

● **Delay factor**—The Assistant Secretary denied that there would be any delay in the program as a result of waiting for the *Titan III*, since the satellites are now the "pacing items." He said that this was due solely to the "procrastination" of DOD, but nevertheless it would not gain any time now to use the *Atlas-Agena*.

Philco is due to deliver the first complement of satellites about December, 1965. *Titan* # 11 should be ready for launch in February, 1966. Fubini added that some delay is already included in the estimates of the *Titan III* schedule.

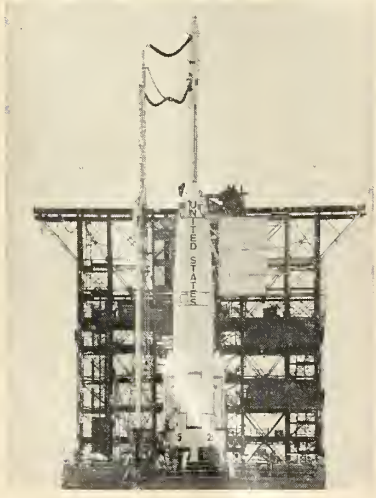
● **Study being made**—Meanwhile, the nations involved in negotiations with the Communications Satellite Corp. have set up a committee to study the problems associated with service to "unique government service," such as the military.

Charyk said DOD pulled out of the agreement after suddenly requiring that its one-half of the satellite be exempt from any international agreements covering the system. He said the most important of these he estimated as being those covering contracting, design of the satellite and budgeting.

Holifield said the committee has from the start foreseen these difficulties, and he indicated approval of DOD's decision to pull out of the shared system. He added that the committee probe report would be finished this week. Holifield indicated that he would favor DOD's going eventually to a mixed system of polar and equatorially launched satellites at different altitudes, to provide world-wide coverage. ■

The News in Pictures

ABOVE: Full-scale mockups of Apollo Service and Command Modules, Lunar Excursion Module, and launch escape system were shown together for the first time recently at North American's Space and Information Systems Div. Dr. Joseph Shea, Apollo director at Manned Spacecraft Center (center, at table), presided. BELOW LEFT: A first photo of Thrust-Augmented Douglas Delta at Cape Kennedy, where it is scheduled to launch Syncom C Aug. 18 (see story, p. 11). BELOW RIGHT: This manned Gemini paraglider test vehicle crashed Aug. 7 during first free flight. After being towed by helicopter to 13,000 ft., glider was released and began smooth free flight. Then it went into a shallow left turn which Pilot Edward P. Hetzel was able to arrest only temporarily. Hetzel bailed out at 1,800 ft., suffering minor injuries. Glider, only slightly damaged, is not scheduled to be used in Gemini flights.





GT-10 To Carry Laser Voice Transmitter

Test to determine feasibility for Apollo use; may solve problem of voice transmission through re-entry plasma barrier

HOUSTON, TEX.—The first transmission from space of voice communications with a laser beam will be attempted in the tenth mission of the two-man *Gemini* spaceflight program.

The test of an IBM-developed system (M/R, June 1, p. 31) will be made to determine the feasibility of such a system for potential use in Project *Apollo*.

Another possible laser beam use, says Woodie Thompson of the Manned Spacecraft Center's Instrumentation and Electronic Systems Div. (IESD), is "communication through the ion plasma during spacecraft re-entry."

The test is but one of the 47 experiments which will be flown during the *Gemini* series.

● **Laser plans**—In particular, IESD wants the laser experiment to determine the effects of the atmosphere on a transmitted coherent beam, and to assess the spacecraft equipment needed to acquire and track a ground receiver in a very narrow beam.

The astronaut will aim a gallium-arsenide pulsed-frequency-modulation (PFM) injection laser transmitter to a ground receiver at White Sands Missile Range, N.M., and will transmit three minutes of voice.

The 10-lb., self-contained transmitter, operating on 10 milliwatts average power and 10 watts peak power, emits a beam of light 0.1-degree wide. The astronaut will speak into the helmet microphone while depressing the laser transmit switch to voice-modulate the signal from the spacecraft.

A second gallium arsenide injection laser located next to the ground receiver presents an infrared beacon pulsing at 10 cps to indicate to the pilot the position of the receiver equipment. The beacon will be tracked for two minutes from the spacecraft with a special infrared image converter included with a sighting telescope. The beacon's flash rate will vary when the pilot's voice modulation is being received successfully on the ground.

A *Nike-Ajax* tracking pedestal at WSMR will be modified to carry and aim a folded, 30-in. collector (Maksutov type) system as well as a narrow-beam laser beacon boresighted with the collector optics and fastened directly to the collector table. The table will be "slaved" to an FPS-16 tracking radar to properly point the beacon and receiver toward the spacecraft.

The optics will focus collected energy (signal plus background) on the photo-cathode of the photomultiplier. AGC circuits, two threshold receiver levels (18 and 10 db), and other signal-processing circuits will recover audio intelligence.

The following data will be recorded on a four-track Ampex tape:

—Processed audio intelligence.

—Signal level derived from a phase-sensitive amplifier or a lock-in amplifier, which detects the carrier voltage unmodulated.

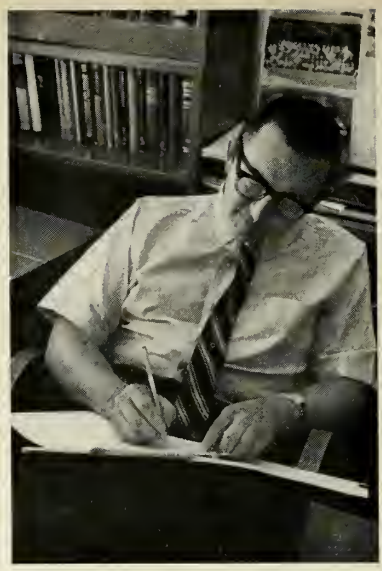
—Background noise levels.

—Clock (1 kc) time pulses from the FPS-16.

With this information, IESD said, it will be possible to determine signal-to-noise ratio and signal strength fluctuations. ■

GEMINI EXPERIMENTS

No.	Experiment	Gemini-Titan
D1	Visual Definition of Objects in Space	5 6
D2	Visual Definition of Objects in Near Proximity in Space	5 6
D3	Mass Determination	6
D4	Radiation Measurements	5 7
D5	Star Occultation Measurements	10 11
D6	Visual Definition of Terrestrial Features	4 5
D7	Radiometric Observation of Objects in Space	5 7
D8	Radiation	4 6
D9	Manual Measurement Techniques for Spacecraft Navigation	6 7
D10	Spacecraft Attitude Determination for Navigation Purposes	10 12
D11	Astronaut Extravehicular Chest Unit	8
D12	Astronaut Extravehicular Maneuvering Unit	9 12
D13	Astronaut Visibility	5 7
D14	UHF-VHF Polarization	8 9
D15	Low-Light-Level TV	8 11
D16	Power-Tool Evaluation	8
MSC-1	Electrostatic Charge	4
MSC-2	Proton-Electron Spectrometer	4 6 7
MSC-3	Tri-Axis Magnetometer	4 6 7
MSC-4	Optical Communication System	10
MSC-5	Ultraviolet Reflectivity of Lunar Surface	10
MSC-6	Gemini Beta Spectrometer	10
MSC-7	Gemini Bremsstrahlung Spectrometer	10
MSC-8	Color Patch Photography	10
MSC-10	Two-Color Earth Limb Photography	4
M-1	Cardiovascular Reflex Conditioning	5 6 7 8
M-2	Cardiovascular Effects	3 4 5 6 7 8 9 10
M-3	In-Flight Exerciser	4 5 6 7
M-4	In-Flight Phonocardiogram	4 5 6 7 8 9 10
M-5	Biochemical Analysis of Body Fluids	6 7 8 9 10
M-6	Bone Mineralization	4 5 6 7 8 9 10
M-7	Calcium Balance Study	7 9
M-8	In-Flight Encephalogram	5 7 9
M-9	Vestibular Effects	7
T-1	Re-entry Communications	3
S-1	Zodiacal Light Photography	5 8 9 10
S-2	Sea-Urchin Egg Growth	3
S-3	Frog Egg Growth	8
S-4	Radiation and Zero-G Effects on Blood	3
S-5	Synoptic Terrain Photography	4 5 6 7 10
S-6	Synoptic Weather Photography	4 5 6 7 10
S-7	Cloud-Top Altitude Spectrometer	5 8
S-8	Visual Acuity	5 7
S-9	Nuclear Emulsion	7 8
S-11	Airglow Horizon Photography	5 9
S-12	Micrometeorite Collection	6 9 10
S-13	Astronomical Observation with Small UV Camera	Not Yet Scheduled



What will John Burr do today?

1. **Save his firm a million dollars?**
2. **Work on a book about tracer applications in organic chemistry?**
3. **Grab a jet and address a conference in Kyoto?**
4. **Consult with engineers on radiolysis of cyclohexane in the presence of benzene?**
5. **Advise the firm's Geneva representative by phone?**
6. **Study a paper on ultrasonic attenuation by chemical reaction?**
7. **Discuss an esoteric molecular structure?**
8. **Lecture on structural chemistry in a university classroom?**
9. **Explore the interaction of ionizing radiation with organic materials?**
10. **Or just gaze out the window and think?**

It's difficult to say what John will do today. His career permits exceptional latitude.

John G. Burr—BS, MS, Ph.D—is typical of more than half-a-hundred scientists actively engaged in fundamental research at the North American Aviation Science Center. Here, inquisitive men like John conduct theoretical and experimental work at the forefront of their chosen scientific disciplines. North American provides them with an environment designed to stimulate their natural scientific creativity.

With this freedom these men explore the scientific nuances which may ultimately benefit all of mankind. Some study the structure of blood, using exotic new tools of physics such as the Mössbauer Effect; others map the symmetrical contours of Fermi surfaces of metals to study their physical properties. Some ponder the extraction of economical electrical energy from the inferno of the atomic reactor; others assist in the science underlying microminiaturization in solid state electronic systems.

And while fundamental research expands scientific horizons, it accelerates America's economic growth through new jobs, new products, new industries. Creating the groundwork for progress like this demands unusual corporate foresight.

North American Aviation

At work in the fields of the future through these divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Science Center, Space & Information Systems

Technical Countdown

ELECTRONICS

MDS To Use Six-Headed Sensor

The 3,400-lb. *Meteoroid Detection Satellite, Pegasus,* being developed by Fairchild Stratos Corp. for Marshall Space Flight Center, will use a novel six-headed attitude sensing system. Developed by Barnes Engineering Co., a prototype and one flight model were recently delivered to Fairchild. Three more flight systems will follow in two months. A key element in the *Pegasus* design, the attitude sensors will be used to determine the direction of travel of meteoroids with respect to the Earth when they impact with the spacecraft's 100-ft. wings. (Two 50 x 15-ft. extendable wings are provided with capacitive detectors capable of measuring particle impact intensity and frequency.) Barnes system employs six optical heads, each having two opposing radial thermopile IR detectors, and a self-contained power supply.

Nortronics' SINS Pays Off

The Mark IV SINS, Ships Inertial Navigation System, developed by Nortronics Div. of Northrop Corp., will finally find operational use. It has been selected for use on the Air Force ARIS range tracking ships by the Navy and will be modified for the surface-vessel application under a $1.2-million fixed price/incentive contract. The system was originally designed as an advanced inertial navigator for use on *Polaris* nuclear submarines, but it lost out in competition with one developed by Autonetics Div. of North American Aviation, Inc. First installation will be on the USAFS Vandenberg.

IR/Surveillance TV Cameras Used for Rocket Tests

A TV warning system that "sees" the invisible flames of liquid hydrogen fires has been installed at the NASA Merritt Island, Fla., space launch complex for manned lunar flights. Developed by Astronautics Div. of General Dynamics Corp., the warning system employs modified industrial TV equipment. The system, Astronautics Div. officials claim, will be of great benefit in developing the high-energy, volatile hydrogen, which until recent years was considered too hazardous for use as a rocket propellant. The system, believed to be the first such unit ever developed to permit visual observation of hydrogen flames, senses the infrared radiation from the fire, then displays pictures of the flames on TV monitors. Heart of the system is a special lens that filters out visible light, allowing only infrared radiation to reach a vidicon tube in the TV camera. In operation, the infrared TV camera is mounted beside a standard TV surveillance camera, with both covering the same field of view. The infrared picture, revealing the fire only, is superimposed over the scene viewed by the standard TV camera, thus visually displaying the exact location of the fire.

Ultra High Speed Reader Used on ABRES

A high-speed electronic film reader, recently installed at the Air Force Missile Development Center, Holloman AFB, N.M., will aid in processing data generated by AFSC's Advanced Ballistic Re-Entry Systems (ABRES) program. The $250,000 unit, built by Massachusetts Institute of Technology, uses optical projection and electronic-beam scanning to read or pick off the pulse coordinates from the radar traces of a re-entry vehicle. The data is then fed into a computer where it may be digitized for human analysis or stored on magnetic tape for comparison with characteristic signature data from other re-entry configurations. The new programmable film reader reportedly reads 1,000 times faster than any film-reading equipment previously available to Holloman's Computation Directorate.

Star Field Mapper Developed

A device which permits ground observers to view a display of the star field under observation by an Aerobee rocket in flight is now going through acceptance tests at NASA's Goddard Space Flight Center. Developed by the Astrionics Center at ITT Federal Labs, the Stellar Pattern Mapper (STARPAT) utilizes an ITT multiplier phototube in which electro-magnetic deflection is used to scan the photocathode. By providing such a view to ground observers, the device makes possible a determination of whether the vehicle is in the proper position during its data collection period.

ETR Gemini Work Under Way

Modification of Eastern Test Range downrange stations to support manned *Gemini* flights has started with the addition of PCM telemetry systems at Grand Turk. The RCA Service Co., which is doing the bulk of the work for NASA and the Air Force, also will install similar equipment on Grand Bahama and Antigua to support the *Gemini* program. The work consists mainly of modifying command systems and adding the PCM equipment and associated computers and recorders.

MATERIALS

Radiation Resistant Glass Sought

Radiation-induced discoloration of glass will be studied for NASA's Manned Spacecraft Center, Houston, by Avco Corp's Tulsa Div. Under a $60,000 contract, Avco researchers will use a space environmental chamber with different types of radiations to determine the characteristics of color change in optical glasses. The ultimate goal is development of better glass for optical instruments and windows for use in future manned spacecraft. The biggest problem, Avco said, will be to subject glass samples to simultaneous exposure to proton, electron, ultraviolet and far-ultraviolet radiations.

Ozone Stabilizer Discovered

Researchers at the Department of Chemistry, Massachusetts Institute of Technology happened across a method of storing ozone that may lead to its use as a rocket fuel. While studying ways to utilize Sunlight, Prof. L. J. Heidt and a pre-doctoral student, V. R. Landi, found that the breakdown rate of ozone can be reduced and smoothed out by increasing its alkaline environment. The chemists kept ozone on a 50% solution of sodium hydroxide for some 83 hours with an ozone loss of 50%. The researchers suggest that ozone might be stored and transported safely in containers whose inner walls were lined with an alkaline material. Both researchers noted that the work involved relatively small amounts of ozone and bulk properties might differ. In addition, the chemical damping action of alkaline compounds on the violently reactive ozone is not known.



VICKERS-ARMSTRONG VA-3 Hovercraft during recent demonstrations conducted on Block Island Sound by Republic Aviation Corp. Republic has a licensing agreement with the British firm to develop and produce the vehicles in the U.S.

space support

Hovercraft Missile Transporter Seen

Republic discloses interest at U.S. debut of British-built vehicle; see use with 156-in. booster, Titan IIIC and Minuteman

by Michael Getler

MONTAUK, L.I., N.Y.—The Air Force is reported to be interested in possible use of air-cushion vehicles—similar in design to ground-effect machines (GEM's), or hovercraft, which have been developed primarily as amphibians—as a means of transporting very heavy missile/space boosters over land.

Scientists from Republic Aerospace Corp., a division of Republic Aviation Corp., are to make a presentation to the Air Force next week on use of an air cushion in conjunction with the ground transporter for the 156-in.-dia. solid-motor segments now under development.

AF Systems Command officers at both Space Systems Div. and Ballistic Systems Div. are also said to be interested in possible application of the technique to transport the *Titan IIIC* booster and the *Minuteman* ICBM. Republic's thoughts on the *Titan IIIC* problem may also be presented next week.

The Republic proposals in this area —in addition to several other new company and Navy/Marine-funded studies under way in the application of GEM's to amphibious, ASW, crash-and-rescue, and passenger ferry roles—are part of a major move by the firm to get into what officials here see as an expanding future market for these vehicles. The firm's initial efforts will be almost totally directed at the military market.

Much of the future Republic work in this field will grow out of the tests it is now carrying out at its main facility here, using the British Vickers-Armstrong VA-3 hovercraft. Though configured as a passenger vehicle (the VA-3 actually did serve as a licensed ferry vehicle in England for eight weeks in 1962—it was the first of its class to serve as such), the VA-3 is actually a test-bed for future Republic design.

The firm has a licensing agreement with Vickers that will give Republic rights to certain basic patents pending in the U.S., which in turn will allow Republic to design and manufacture new vehicles based upon VA-3 principles. Vickers will share in any future Republic sales in this area, although Republic intends to proceed with its own designs beyond VA-3.

● **Trial run**—The first press demonstration of the VA-3 in the U.S. was held here recently. Reporters were taken on a 20-minute ride in the 55-ft.-long, two-ton VA-3 at speeds up to 45 knots over water, crossing several short strips of beach and marsh enroute. Top speed of the VA-3 is said to be over 50 knots. The vehicle uses four gas-turbine engines, each rated at 425 shp —two to create the downdraft at the water's surface, and two acting as propellers, or pushers, for forward motion. A pair of vertical stabilizers deflect the prop air stream for directional control. The vehicle is fitted with a 36-in.-high flexible neoprene-coated "skirt" that contains the air cushion beneath the vehicle. The fans which lift the VA-3 between one and three feet out of the water exert about 35 lbs./sq. ft. pressure.

Should Air Force interest expand into actual hardware development and procurement, as some officials here believe it will, it could develop that the

first operational use of these devices by the U.S. military would be in an overland capacity, rather than in the amphibious role with which GEM's have been traditionally associated.

First Republic proposal on the 156-in. program reportedly was made about two months ago. It is now understood that the Air Force, expected to pick a subcontractor in the next 2-3 months for the 156-in. segment transporter, will direct the contractor to contact Republic with an eye toward analyzing possible air-cushion application to the transporter.

● **Load relief**—Republic officials here say that with such a system the major individual wheel-axle loads on the transporter could be reduced from an estimated 52,000 lbs. on each axle to about 20,000 lbs., putting the loads within state highway limits. Program sources here believe it is possible to have an air cushion-type transporter in use in this program in about a year. Engineers here estimate it would take about 800-1,000 hp delivered to the fans to do the job.

Vickers has already done much research on large vehicles and overland transporters and has reportedly built and tested smaller models of these devices.

BSD interest in the principle for *Minuteman* applications involves a transporter in which axle loads could be reduced from about 22,000 lbs. to about 12,500 lbs. according to Republic.

Regarding overland transport or moving missiles into soggy or difficult terrain, Republic estimates that loads on the wheels can, in general, be relieved by about 73% using the air-cushion principle, while still allowing enough weight on the wheels for traction and steering.

● **Landing craft**—In the Navy/Marine area, Republic is now working under a $100,000 Marine Corps/Office of Naval Research (ONR) contract aimed at evaluating the hovercraft, using the VA-3 for initial trials, as a high-speed, long-range amphibious logistics support vehicle capable of being carried in large LPD vessels and delivering a platoon of Marines or about five tons of equipment.

The ONR contract began in April and runs through October. The tests, which the Marines want before making any decision on going ahead with heavy funding, are now at the 80-hr. mark; Republic reports it has made successful beach landings in surfs running to six feet. The VA-3 also reportedly has hit speeds of 39 knots in Sea-State Three conditions.

The need for the five-ton carrying craft was reportedly pointed out in a Marine/ONR study completed about two years ago.

Republic officials, hopeful that funds for such a development—more than likely a competitive award—will be included in the Fiscal Year 1966 budget, have been at work for the past six months designing the RACV-2 vehicle. This will be proposed as a 35-ft.-long, 27,000-lb.-gross-weight amphibian, with a 70-knot cruise speed and a 220-n.mi. range allowing loading and launching operations far beyond normal offshore operating range. Republic says it could turn out such a vehicle in about 18 months. The firm feels that a Navy vehicle able to load 50-60 tons may prove to be the next step if the five-tonner is shown to be feasible.

● **Anti-sub**—In the ASW area, Republic has already submitted a proposal to the Navy for a through-the-water sound transmission study of the VA-3. Republic officials point out that while the VA-3 in its current configuration is a relatively noisy vehicle, all of the engine sound is out of the water, and in fact very little of the air energies exerted on the surface are actually dissipated in churning up the water. They also point out that noise levels in the craft, which could affect listening capabilities, can be greatly reduced in redesign from the experimental passenger vehicle.

Republic maintains that hovercraft are quieter for ASW operations than are hydrofoils. They also claim that these craft require none of the automatic stabilization systems of hydrofoils for heavy sea operation.

Republic is also known to have contacted the Raytheon Company, a major producer of ASW equipment for the Navy, to aid in evaluation of VA-3 type capability to house and operate ASW equipment.

In the Fiscal Year 1965 Dept. of Defense budget, $2 million was requested for use in determining the "military usefulness, technical feasibility, and cost/effectiveness of air-cushion ships for the amphibious, mine warfare, strike, and ASW missions." DOD says that the air-cushion ship concept, "because it provides for the physical decoupling of the hull from the ocean, has several potential advantages—including high speed, low magnetic signature, and internal ship arrangements not limited by conventional hull forms."

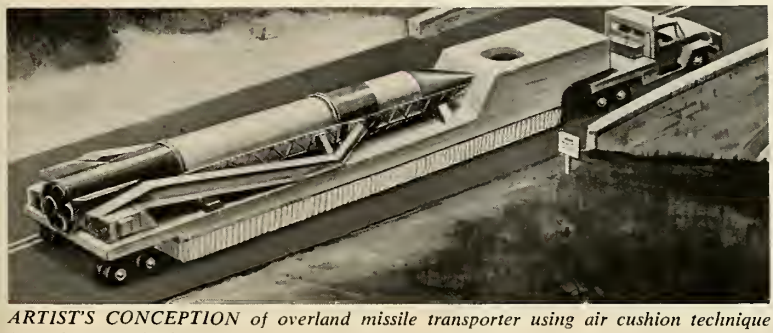
● **Civilian use**—In the commercial sector, Mundy I. Peale, Republic president, said that while the hovercraft is not now at the point where it could compete with more traditional transportation for many direct routes, studies made by the firm show that the vehicles can operate "cheaper than a helicopter, maybe by 50%." Peale pointed out that by development of new lightweight air-cooled Diesel powerplants to replace the aircraft engines now being used, operating costs could be reduced even further.

Republic has already made studies and proposals on using hovercraft systems as passenger ferry vehicles at airports, such as New York and San Francisco, where the field is situated near water. The firm has also designed a 43-ft. crash-and-rescue vehicle fitted with collision and firefighting equipment for use at such airports.

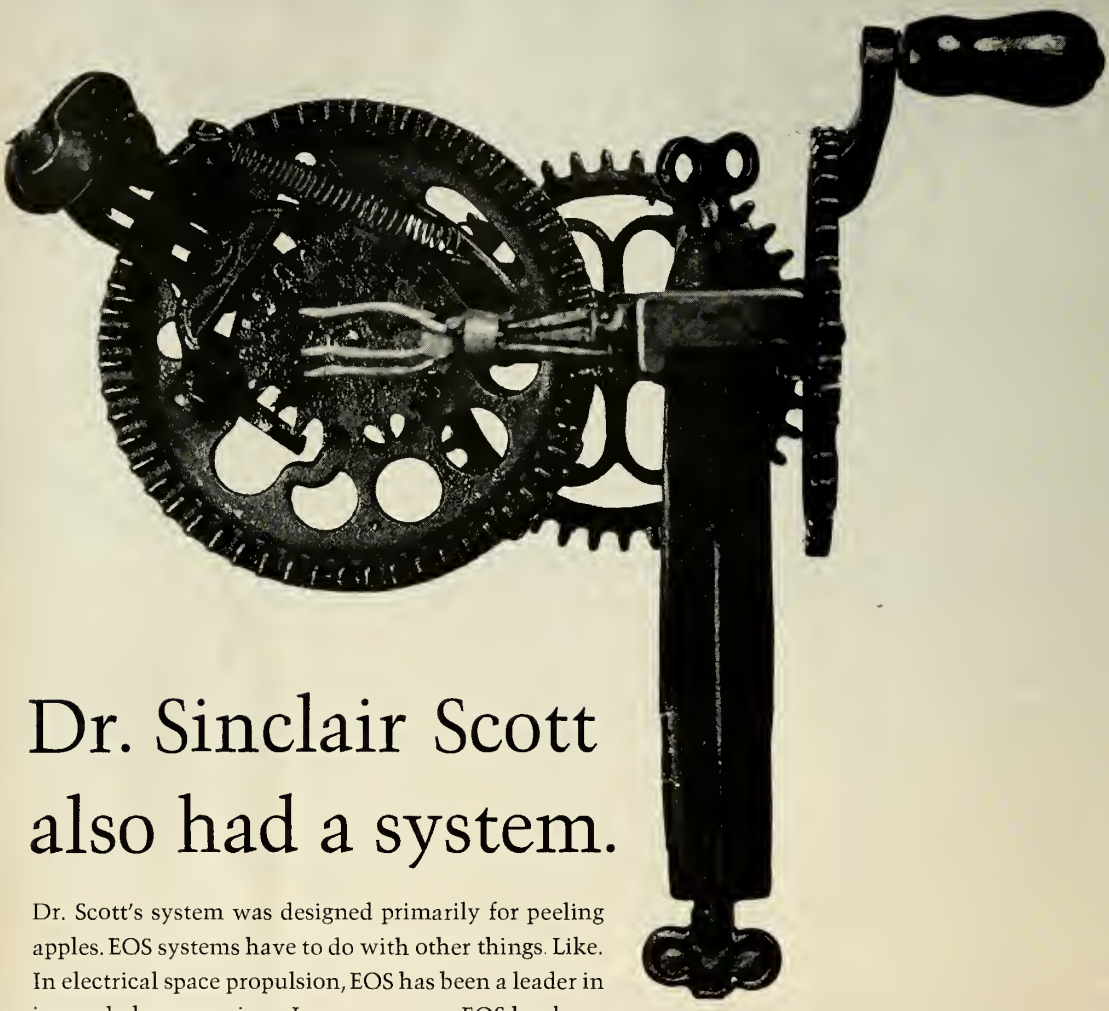
Other performance tests of the VA-3 have shown, developers say, that it can accelerate from 0 to 50 knots in 15 sec., can stop in 200 ft. from a 40-knot speed, and can turn in its own length in static hover. The vehicle has an integral buoyancy tank system so that it will float in the event of fan failure, and reportedly can make 4-5 knots while floating. The VA-3, according to Republic, can retain some operational ability on just one fan.

While Republic's entry into the hovercraft field is new (although Vickers has been in the field for many years) six nations now are actively engaged in research and development in this area. They include Britain, the United States, Japan, Russia, France, and Sweden. Within the U.S., in addition to Republic, Bell Aerosystems Co., Douglas Aircraft Co. and Martin Co. are developing research vehicles.

If Republic moves ahead with its amphibious proposal plans as expected and development funds are made available, the firm expects to get major competition from the Bell Aerosystems Co., which has pioneered in the U.S. military with the development of its "hydroskimmer" vehicle under Navy support. The hydroskimmer is a larger and faster vehicle than the VA-3, and is now under test by the Navy. ■



ARTIST'S CONCEPTION of overland missile transporter using air cushion technique for relieving wheel loads.



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Aerojet Proves 260-In. Case Method

Subscale chamber withstands 4,300 psi for 2 minutes; achieves strength-to-density ratio of 1.5 million psi/lb./in^3

DESIGN AND FABRICATION processes for the world's largest filament-wound glass-reinforced rocket motor case are now verified with the successful testing of a sub-scale chamber by Aerojet-General Corp.

The burst test—carried out on a chamber 54 in. across and 11 ft. long—demonstrated the feasibility of the construction methods to be used by the firm in winding a 260-in.-dia. solid rocket motor case 100 ft. in length.

Aerojet is designing, building and hydrotesting the huge case under a contract with the Manufacturing Technology Division, Air Force Materials Laboratory at Research and Technology Div., Wright-Patterson AFB.

The sub-scale model had a wall thickness of 1.25 in., precisely the same as the programmed full-scale case. The test chamber was filled with water and subjected to steadily increasing internal pressure at the rate of 1,000 psi/min. until the proof pressure of 4,300 psi was reached. This pressure was held for 2 minutes.

Pressure was then increased until the case burst at 5,070 psig. This means a composite hoop stress of 113,000 psi was reached with a strength-to-density ratio in excess of 1.5 million psi/lb./in^3.

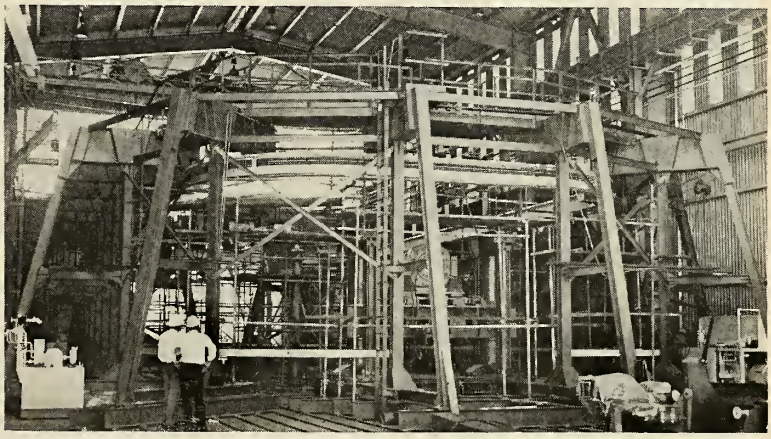
In addition, the attaching method used in the skirt was tested by applying compressive loads simultaneously with the increasing internal pressure. The skirts withstood a total load of 1.3 million lbs.

The test was performed at the Von Karman Center in Azusa, Calif., but the massive case will be fabricated at Todd Shipyards, San Pedro, before the end of 1964.

The Rucker Co. of Oakland, Calif. is installing the huge filament-winding machine at Todd. The 100-ton mandrel is being built by Precision Fabricators, Inc., into a single massive cylinder, which will then be cut into nine segements. The segments, joined by bolts, will support the winding operation and then can be removed in sections through the 9-ft. nozzle port opening. ■



The huge mandrel designed to support the winding of Aerojet's 260-in., 100-ft. glass motor case is shown during construction at Precision Fabricators, Inc. In final form, the mandrel will weigh over 100 tons, yet be extractable from the case.



The huge winding machine for the 260-in. case is nearing completion at Todd Shipyards. The fabricating unit is 20 ft. high, 45 ft. wide and nearly 125 ft. long. Glass roving will be applied to the mandrel by a winding head apparatus mounted on a track which moves horizontally around the mandrel.

— Circle No. 4 on Subscriber Service Card

Getting there is only part of the program

What Boeing is doing



bout MOON EXPLORATION:

Rocket Power

Boeing holds the NASA contract to develop, build and support the testing of the first-stage S-1C booster on Saturn V, the free world's largest rocket. The S-1C will put 160,000,000 horsepower behind the first mission to put Americans on the moon.



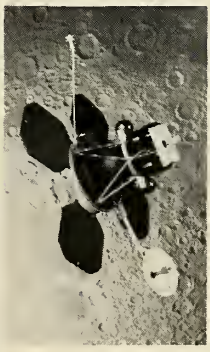


Lunar Laboratory

Boeing has conducted company studies that theoretically put four men on the moon for 90 days, headquartered in structure above. Boeing holds NASA contract to study supply and support of a moon expedition, including design of vehicle for exploration of the moon's surface.

Lunar Orbiters

Boeing is building eight lunar orbiters for NASA, three for ground test, five for flight. Launched from Cape Kennedy, they will orbit the moon, take and transmit close-up photographs of the lunar surface and measure the density of micrometeoroids and radiation.





Moon Surface Studies

Boeing researchers are carrying out moon mapping and surface temperature studies. And as part of a NASA Lunar Base study, Boeing is evaluating radio communication techniques for use between lunar bases, transmission of TV data and effects of lunar climate on electronic equipment.

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Data-Processing Subsystem To Refine Air Force's 473L Pentagon Complex

Librascope-developed unit, now undergoing acceptance tests, will greatly speed system's response, increase flexibility

by Rex Pay

GLENDALE, CALIF.—By the end of this year, the 473L command and control system, at Headquarters USAF in the Pentagon, will be augmented by a new data-processing system that will speed response by an order of magnitude and greatly increase flexibility.

Linked to a globe-girdling network of defense communications, the 473L system is designed to collect, store, process, exchange, and display all current information associated with Air Force resources and the many conditions that affect them.

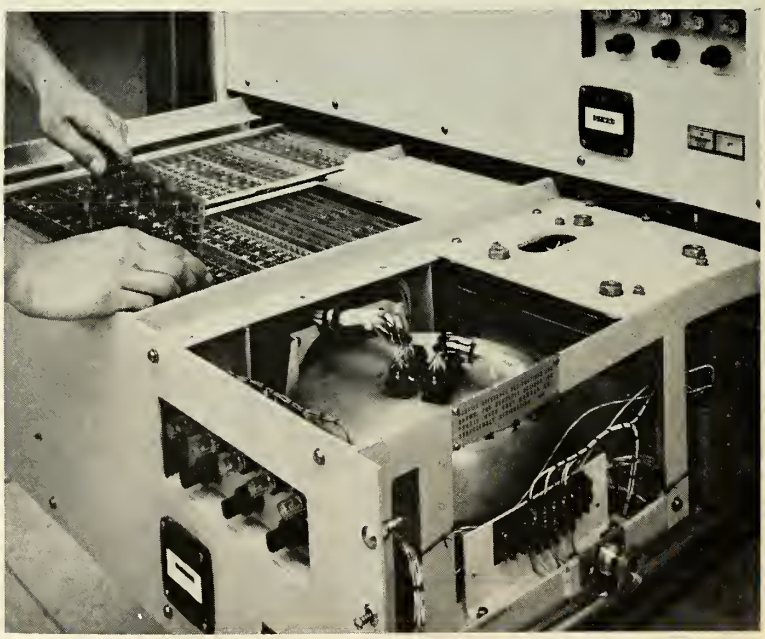
A significant feature of the new computer subsystems being installed is the use of content-addressable, or associative, memory stores.

Function of Air Force Headquarters in the Pentagon is to support operations of the Joint Chiefs of Staff, the Secretary of Defense, and the President. Principal use of the 473L is in situations other than general war, specifically, for planning operations of the contingency type.

Missile force allocation is primarily a matter between the Strategic Air Command and the Joint Chiefs. But Air Force Headquarters does get into the act to some extent during the planning stage.

The new data-processing subsystem responsible for the upgrading of 473L capabilities, the AN/FYQ-11, was recently demonstrated at the plant of its manufacturer, Librascope Group of General Precision, Inc., located here. The first parts of the subsystem are undergoing USAF acceptance tests.

Present envisaged programs will contain about 500,000 instructions.



TECHNICIAN inserts circuit board into logic section of L-119 buffer processor, a key element in the AN/FYQ-11 data processor for AF's 473L command & control system.

Basic contract for the Air Force system was awarded to GPI in May, 1962. Since then the system has been modified and expanded in size. Three complete systems are being procured under a contract amounting to about $6 million. Two will be used for a duplex system in the Pentagon, with extensive capabilities for switching elements from one to the other. The third system is intended as a backup for the Pentagon system, and is scheduled for installation at an undisclosed site.

First unit of the three was delivered to the Air Force June 30. It is being used at the Glendale plant by the Air Force. Second unit will be delivered in August this month and the third unit in the middle of October. Installation in each case follows delivery date by about one month.

● **Improving the system**—A version of the 473L system is in operation now at the Air Force Command Post, but the AN/FYQ-11 will provide a step forward in speed and capability. The 473L system has been developed on an "evolutionary" basis, with improved techniques and equipment gradually phased into operation.

The efficiency and speed with which

the improved 473L will perform its duties are attributed in great part to a capability to operate on a "positive exception" principle. Information about USAF installations and operations is transmitted to the 473L's data-processing system, which compares the data to a plan on its memory.

If incoming information indicates that a plan is being carried out in a normal fashion, the data-processing system merely updates its records. However, if a variance or exception, is noted, the data-processing system brings the condition to the attention of the cognizant agency at the Pentagon.

Linking Librascope's AN/FYQ-11 data processor set with the world-wide Autodin military communications network are smaller communications-processing computers, called L-119 buffer processors. These automatically receive and transmit messages and other data.

The data-processing system can include an array of up to 256 devices, called the uni-record subsystem. This equipment consists of high-speed magnetic tapes, card reader/punches, and high-speed printers that print at the rate of up to 1,000 lines per minute. This array of equipment is used for high-volume data storage, data conversion, and printing tasks.

● **'Core store'**—The bulk of USAF information is held in large magnetic disc files. These content-addressable files contain their own control logic. A unique feature of this is a core store that contains three registers: a key register, a mask register, and a current record register.

The key register carries the description of the desired information; the current record is continuously loaded with information that is stored on the disk. When the desired information in the key register coincides, through the mask register, with that in the current register, the particular block of information is either labeled (flagged) or extracted directly.

A basic block of information within the file contains 128 characters, with six bits allocated to each character. In the searching process, the mask can specify that the key and current record register should contain characters that equal each other, or one should be less than or greater than the other, or upper or lower boundaries can be specified. For the last type of information, the upper boundary is carried in the key register, and the lower boundary in the mask.

There are 20 different operations in the file that can be specified by the program.

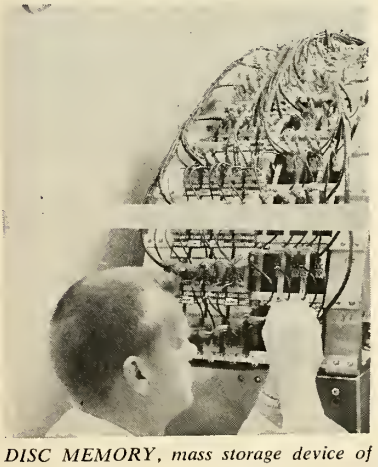
With this sort of search capability, the system can make a rapid search for information with any specified characteristic. For example, it can pick out airfields or missile sites that meet specified conditions such as latitude, altitude, communications facilities, strike range, and so on.

The content-addressable system was conceived as a method of avoiding much of the programming chores associated with the retrieval of information from large stores. Experience has shown that much programming is saved by the absence of a need to store a large number of address tables. But the programming that tells the machine how to use the file has turned out to be much more complex than was originally thought.

● **Man-machine communications**—Considerable attention has been given to the problem of communications between the machine and the operators. Nine operators can use the data base at the same time. Each of the nine inquiry stations to be installed at the Pentagon system has a logic keyboard for demanding information. This contains sets of keys over which any one of a series of overlays can be fitted. There will be an overlay for each type of inquiry operation, and each overlay is fitted with electrical contacts and English statements identifying the function of each key.

When a particular overlay is fitted—for example, one used for demanding information about the number of airmen at various missile bases—depression of a key will transmit a specific instruction message to the machine, unique to that overlay and that key. With very little work by the operator, very complex computer problems can be specified.

In response to a brief key inquiry, a disc memory can run a search through its entire file in about 0.035 second and extract all records associated with the key.



DISC MEMORY, mass storage device of the AN/FYQ-11 data processor, is checked and adjusted before installation in console.

Associated with the integrated console system (AN/FYA2) is an electronic typewriter system. This consists of an electric typewriter, cathode ray tube system, and core buffer. After typing a message which enters the core buffer, the operator can see the contents of the buffer displayed on the cathode ray tube. Having verified that the message is correct, the operator pushes a button and it is transferred at very high speed to the central processor.

The display of information is one of the areas that will be investigated in the near future. One system developed makes use of a cathode ray tube device that is capable of drawing vectors as well as displaying digital information. This unit, contracted by the Air Force to International Telephone and Telegraph, is capable of drawing pictorial displays as well as text, and could be used, for example, to draw maps showing aircraft deployment at various cities within a given area.

● **Contracting & management**—The AN/FYQ-11 subsystem was produced under a contract to the Electronic Systems Division of the Air Force Systems Command, which is responsible for overall management—including development of equipment, procurement and installation—through the 473L System Program Office.

Air Force Headquarters, user of the system, has provided operational guidance during the development/production cycle through the Air Force Command Post Systems Division under the USAF Deputy Chief of Staff/Plans.

The MITRE Corp., Bedford, Mass., has acted as technical advisor to the 473L System Program Office. International Telephone and Telegraph Federal Laboratories and International Business Machines Federal Systems Division are major contractors for the 473L system: ITTFL for the input/output subsystem and IBM for the operations analysis and programming.

Other features of the computer system are off-line (over-lapping) data transfer to all peripheral units (magnetic tapes, disc memory, operator consoles), and a comprehensive interrupt technique that is carried out automatically without operator attention. Alphanumeric representation is used throughout the system.

The data processor group is made up of two solid-state digital computers, each with 32,000 words of core memory. The disc memory group at the Pentagon installation will initially consist of two large units each capable of storing 20 million characters (about 120 million bits). Two more files will be added later. Each file unit has six 48-in. rotating discs. Under a retrofit contract, Librascope will upgrade the capacity of each file unit to 40 million characters, giving a total storage of 80 million characters per processor. ■

Marquardt Exploring Air Augmentation

by Russell Hawkes

Both NASA and Air Force are supporting studies of potential of rocket-ramjets with afterburners

BOTH NASA and the Air Force are supporting research and development work by Marquardt Corp. on composite rocket-ramjet engines with afterburners, viewed as a highly advanced propulsion system for both launch vehicles and high-performance aerospace craft.

Even nuclear-propulsion launch systems are expected to gain improved performance from the addition of ramjet air-augmented ducts.

Marquardt has a contract from NASA to investigate advanced air-augmented rockets for space launch vehicles; it likewise has an award from the Air Force Research and Technology Division for a study of advanced ramjet types for aircraft. Optimum geometry of the two is very similar, but the company refers to the system as an Ejector Ramjet when discussing it with the Air Force, and as an Advanced Augmented Rocket Propulsion System (AARPS) when talking with the space agency.

In actual systems there would, of course, be numerous differences in detail. For instance, the relatively short burning times for launch vehicles might permit ablative cooling, while regenerative cooling would be needed for the prolonged cruise of an aerospace craft. Only in recent months has Marquardt felt that the problems involved were well enough in hand so that it could begin conversations with airframe companies about potential applications.

● **Interim prospect**—Much of NASA's interest in air augmentation stems from the fact that there is little chance that brand-new launch stystems will be funded in the next few years. Any big advances in performance must come from relatively inexpensive improvements to the systems already in development. Ejector ramjets or air-augmented rockets with afterburners promise to offer such an improvement, and the additional performance seems to more than offset the additional weight.

Marquardt has simulated altitude and aerodynamic heating variables in tunnel studies, but as yet there has been no flight test of an afterburning rocket. The engineers are optimistic about the prospects of heavier government funding, which would make it possible to start flight testing within two years. They say they can deliver the flight-test hardware a year from go-ahead.

Present work covers only subsonic burning in the ramjet duct. However, Marquardt has achieved stable combustion in a supersonic flow and is convinced that supersonic combustion ramjets are feasible and could be adapted for afterburning air-augmentation of rocket engines.

While no specific work has been done in the field, Marquardt engineers regard it as obvious that the nuclear rocket can benefit enormously from air-augmentation. The system produces a tremendous volume of highly combustible hydrogen; if this can be burned efficiently in an air-augmentation duct, great performances increases should be available with virtually no penalties.

● **Essence of system**—A basic air-augmented rocket is little more than a conventional rocket surrounded by a simple shroud. It is an ejector pump that imparts some of the primary rocket cxhaust momentum to the air in the duct, drawing in more air through the duct inlet, heating it and mixing it with the rocket exhaust. It is supposed to increase total mass flow and thrust without expending more propellant.



ARTIST'S DRAWING of Advanced Air-Augmented Rocket Propulsion System (AARPS) in use on a space launch vehicle.

At high speeds the ram effect of the air at the inlet compresses duct air and the ejector pumping becomes less important. Up to about Mach 0.6, there actually is a slight reduction in thrust because of the work that the primary rocket must do upon the relatively static air in the duct. Beyond that point ram effect more than makes up the loss. Marquardt believes the overall performance payoff of such a system is marginal at best.

Company engineers feel that one point is often overlooked by rocket technologists studying air-augmentation: by the time the air-augmented rocket has reached Mach 1.0, more than 65% of duct air-compression is accomplished through ram effect—only 35% by the ejector effect; by Mach 3.0 the proportions are well over 80% by ram and less than 20% by ejection.

Marquardt's program is based upon utilizing the potential for combustion of the secondary air flow in the duct. The only air-augmented rocket found to show an advantage over a simple rocket at liftoff is one that uses an afterburner in the duct. One way of getting some afterburning is to run the primary rocket fuel-rich, so that combustion occurs automatically when the rocket exhaust mixes with the secondary air. Even so, there is a net loss at low Mach.

Either way, by Mach 2.0 the propulsion system is functioning primarily as a ramjet. The use of free air as a propellant gives the ramjet an effective specific impulse of about 2,000 compared to less than 300 for chemical rockets. This suggests that the fuel allocated to the rocket part of the system and that allocated to the ramjet part should be programmed to go where it is used most efficiently.

The primary rocket is most effective at low Mach numbers, immediately after launch, and at extreme high altitude, where there is little oxygen to support combustion in a ramjet. After launch the flow of propellants to the rocket could gradually be throttled and fuel to the afterburner increased. Marquardt engineers believe there would be an advantage in shutting down the

(Continued on page 33)

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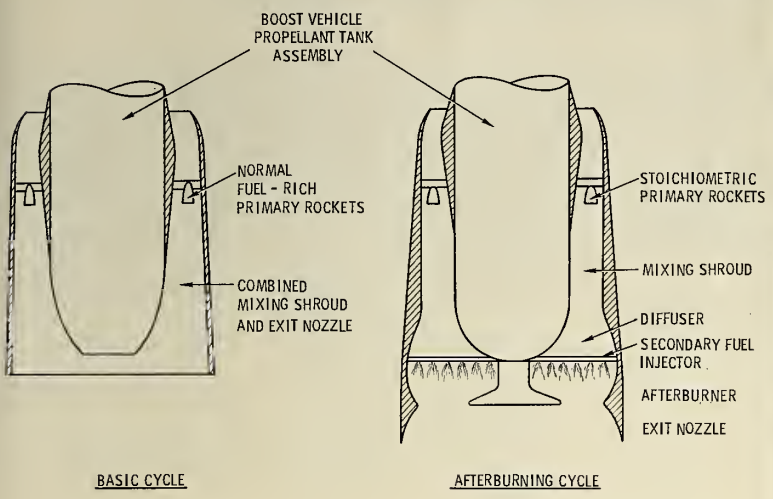
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AIR-AUGMENTED ROCKET ENGINES



primary rocket completely and having the system function entirely as a ramjet during part of the launch. At extreme altitude the rocket system would be restarted and programmed up to full thrust, and the duct inlet sealed to prevent losses due to backflow. The duct would need a variable geometry exit so that the nozzle throat could be opened in the pure rocket mode to keep flow supersonic.

● **Exploitation**—Availability of high specific impulse at middle altitudes with air-augmented rockets would bring about a redrawing of launch trajectories. By programming the pitch-over at low altitudes and accelerating to high speeds and dynamic pressures within the atmosphere it would be possible to capitalize on the advantage.

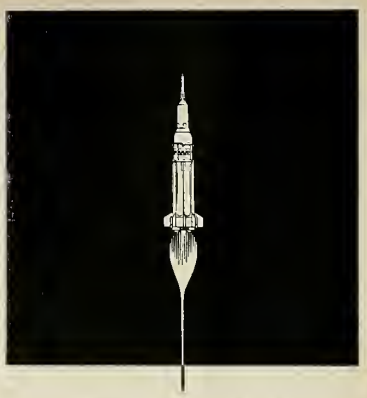
Marquardt's work is directed toward reusable booster applications, including winged and wingless types. If it seems worthwhile to carry the additional weight and drag of wings, this would increase the trend toward flatter launch trajectories—since the lift generated by the wings might as well be used to produce part of the altitude gain, freeing more of the propulsive thrust to produce horizontal acceleration.

An afterburning air-augmentation system is relatively light and has no moving parts. The length of the duct —and hence its weight—can be minimized by using a circular cluster of smaller primary rockets rather than a single large engine. With the single primary the duct length must be from five to eight times its diameter to get good mixing of the primary exhaust and the secondary flow. With 10 or 12 primary engines this can be accomplished within two duct diameters—or even less, with some of the unconventional plug-type nozzles that have been proposed.

If the weight of propellants and tankage is ignored, the thrust-to-weight ratio of an air-augmented engine functioning in the pure rocket mode is not as good as that of a simple rocket—about 25 as compared to 75. However, ramjet propellant economy during the middle of the launch trajectory provides a weight saving that more than counterbalances this and should permit larger payload fractions.

Aerodynamic drag of the air-augmentation duct is not insignificant, but it is less important than the weight problem. It is calculated that the weight penalty is 10 times the drag penalty in an optimized launch trajectory.

There is reason to believe that an afterburning air-augmented launch vehicle designed from scratch would have only one stage. Because of the effect of the secondary flow in the duct, the nozzle system appears over-expanded for sea-level operation when compared with simple rockets. However, the high area ratio is desirable at the altitudes where the system functions as a simple rocket. In this case, area ratio is described as duct exit area over the sum of the primary nozzle throat areas. ■



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To perform dynamic analyses for frequencies and mode shapes of elastic structures; stability analysis of elastic vehicles to determine control filter requirements and tank baffling; response of elastic vehicles to winds to determine maximum bending moments, shear loads and trajectory errors.

FLIGHT MECHANICS ENGINEERS and SPECIALISTS

. . . with experience in flight path optimization, propellant loading analysis, impact dispersion of spent stages, rigid body control, dynamics of stage separation, determination of abort sensing parameters, and lift off motion studies. Must be familiar with six degree of freedom trajectory digital simulation techniques.

FLUID MECHANICS ENGINEERS and SUPERVISOR

To supervise selection and development of analytical and experimental techniques for solutions to fluid dynamic problems (aerodynamic and structural heating, cryogenic storage, boundary layer theory, reaction kinetics and ablation, fluid flow problems and gas dynamics).

THERMODYNAMICS ENGINEERS

To perform analyses of aerodynamic heating, structural, tank and base heating and related heat transfer studies, and direct methods development studies.

SYSTEMS ENGINEERS

for following activities:
- Propulsion
- Vehicle System Design Analysis
- Functional Analysis of Launch Requirements
- Vehicle Assembly & Checkout Planning
- Design Criteria (Manuals)
- Design Compatibility
- Configuration Control & Engineering Liaison

Minimum 3 years experience required.

Excellent positions in other disciplines are also available in Huntsville and Cape Kennedy, as well as in New Orleans.

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ENGINEERS AND SCIENTISTS:

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HUNTSVILLE

Lockheed Missiles & Space Company's new Research & Engineering Center, adjacent to the University of Alabama's Research Center, was created to lend close support to NASA's George C. Marshall Space Flight Center.

FLIGHT MECHANICS—Launch system capability • Systems evaluation • Accuracy analyses

CONTROLS & DYNAMICS ANALYSIS—Rigid and flexible vehicles • Analog and digital simulation

GUIDANCE THEORY—Calculus of variations

GUIDANCE ANALYSIS—Guidance laws and requirements

PROPULSION—Propulsion systems • Solids & liquids

THERMODYNAMICS—Aerodynamic heating • Heat transfer • Boundary layer theory

GAS DYNAMICS—Analysis of internal/external flow

AERODYNAMICS—Stability & control • Aerodynamics characteristics

STRUCTURAL STATISTICS—Variance stochastic processes • Response to random excitation

ENGINEERING ACOUSTICS—Vibration & acoustic environmental criteria

STRUCTURE DYNAMICS—Fuel slosh • Launch vehicle dynamics

DIGITAL PROGRAMMING—Scientific computation

ANALOG PROGRAMMING—General or hybrid systems

SUNNYVALE

The Bioastronautics Laboratory's extensive research and development facility is undertaking a comprehensive manned system simulation program, in line with Lockheed's expanding capability in manned systems development.

MANNED ALTITUDE SPECIALIST—Manned (hyperbaric) experimentation chambers

EXPERIMENTAL PSYCHOLOGIST—Simulation of visual perception phenomena

CONTROLS-DISPLAYS PSYCHOLOGIST—Aviation psychology for controls & displays

SUBMARINE MEDICAL SPECIALIST—M.D., experienced with submarine or diving crews

FLIGHT SIMULATION SPECIALIST—Simulator & servo-engineering

BIO-MANIPULATION SPECIALIST—Servo-devices for remote handling

HUMAN PHYSIOLOGIST—Research re altitude chambers, simulators, etc.

BIO-ACOUSTICS SPECIALIST—Communications and Psycho-Physics

PALO ALTO

The Aerospace Sciences Laboratory has integrated the specialized skills of highly qualified research personnel to work on a variety of challenging programs, in the development of advanced aerospace systems.

AEROPHYSICS—Superorbital reentry • Hypersonic flow

FLIGHT MECHANICS—Trajectory optimization • Mission analysis • Interplanetary navigation

THERMOPHYSICS—Cryogenics • Surface physics

ENVIRONMENTAL EFFECTS—Transient nuclear radiation effects

MATHEMATICS—Reliability research • Statistics

SOLID MECHANICS—Experimental mechanics • Stress analysis • Structural methods

AEROSPACE SYSTEMS—Reentry effects • Meteoroid hazards • Systems integration

FOR IMMEDIATE CONSIDERATION for all of the above positions, qualified applicants should write or send a résumé to Research & Development Staff, Lockheed Missiles & Space Company, P.O. Box 504-U, Dept. 27/11, Sunnyvale, California. AN EQUAL OPPORTUNITY EMPLOYER.

LOCKHEED MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Fairchild, Republic Trade Directors

Fairchild Stratos Corp., whose large-scale buying of Republic Aviation Corp. stock came into the open recently (M/R, June 29, p. 17), has placed two directors on Republic's 12-man board, and has influenced the election of two Republic officers to its own board. Fairchild president Edward G. Uhl and Walter Burke, a Fairchild director and executive committee member, have replaced Republic board members Lawrence Wilkerson and Russell C. Taylor, who resigned. Republic president Mundy I. Peale and William V. Platt, a Republic board member, were elected to the Fairchild board on the recommendation of Uhl.

New Activities

International Electronic Research Corp., Burbank, Calif., has linked five of its divisions in a new systems capability to serve the military and industrial markets. Designated IERC Systems, the operation can design, engineer and manufacture subsystems or systems requiring skills ranging from telemetry to precision machining. The five divisions affected are: Elin, High Reliability Circuit Systems, Telemetry, IERC Div., and Millrich Engineering. . . . *Motorola Semiconductor Products Div. has formed a new department devoted to the manufacture and sale of semiconductor test equipment and selected production equipment.*

Industry Facilities

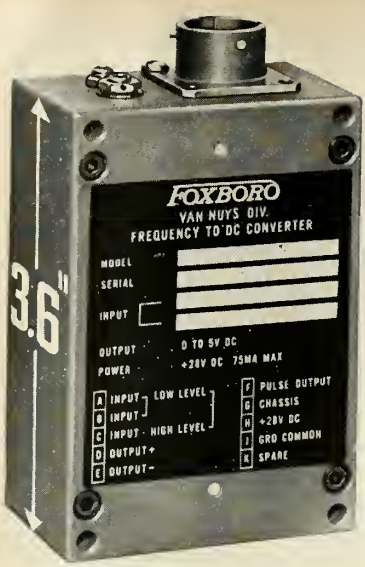
Lockheed Missiles and Space Co. plans to build a major addition to its cryogenic test facility at the firm's Santa Cruz Test Base near Sunnyvale, Calif. Included in the plans is a 25-ft.-tall, 16-ft.-dia. vacuum chamber for testing space vehicle propellant tanks containing liquid hydrogen, and also complete space vehicles. . . . *Amphenol-Borg Electronics Corp. has opened a new facility in Broadview, Ill., for the production of electronic interconnection systems, thin-film deposition and custom electronic packaging.* . . . The Dept. of Interior's Geological Survey has broken ground on a new building in Flagstaff, Ariz., to house its astrogeology laboratories. When completed, the 14,000-sq.-ft. facility will contain scientific laboratories and equipment designed to support the lunar geologic mapping program and basic lunar research carried out by the Survey for NASA. . . . *Telemetrics, Inc., a subsidiary of Technical Measurement Corp., has moved from Gardena to Santa Ana, Calif. The firm has occupied a new 42,000-sq.-ft. headquarters building and 38,400-sq.-ft. manufacturing and support facility.* . . . Honeywell, Inc., has completed a 32,400-sq.-ft. space environmental test facility adjoining its Aeronautical Div. headquarters plant in Minneapolis. . . . *The Bruning Co., manufacturers of precision quick-disconnect couplers, hydraulic cylinders and valves, has begun construction of a new manufacturing plant in Lincoln, Neb. The building will afford 57,000 sq. ft. of space, with provision for an additional 23,000 sq. ft. in floor space.* . . . Kamis Engineering Co., missile/space machinists, has begun construction of a new one-story, 50,000-sq.-ft. plant in Bethayres, Pa. The firm plans to move to the new plant from its present downtown Philadelphia location early next year. . . . *The Dow Chemical Co. will build a new facility in Denver. To go into operation in mid-1965, the facility will be used to produce precise metal, plastic and ceramic products by numerically controlled machining coupled with environment control.*

Representatives Named

Motorola Semiconductor Products, Inc., Phoenix, Ariz., has named Cresent Electronic Sales Co., Orlando, Fla., as representative responsible for serving Florida, Georgia, Alabama and Mississippi. . . . *Microwave Components and Systems, Corp., Monrovia, Calif., has appointed Budd Meyers Assoc., Roslyn Heights, N.Y., as engineering sales representative to service New York, New Jersey and Connecticut.* . . . Redcor Corp., Canoga Park, Calif., manufacturer and designer of components and systems for data acquisition, has named new representatives for southern California, northern California and Nevada. Dietrich Assoc., Burbank, will represent Redcor in southern California; R. R. Sedillo of the Sedillo Co., San Jose, will be responsible for northern California and Nevada. . . . *Texas Instruments, Inc., Dallas, has appointed DeMambro Electronics of Boston as authorized distributor of TI semiconductors in the Boston area.* . . . LTV Ling Electronics Div. of Ling-Temco-Vought, Inc., Dallas, has announced that S. Sterling Co. Southfield, Mich., will be representative for its vibration and acoustic environment test equipment in Michigan, Ohio and Southwestern Pennsylvania.

International

Fairchild Camera and Instrument Corp.'s Space and Defense Systems Div. has named AEROBEL (Compagnie Générale Belge D'Aeronautique), Brussels, as a sales representative. AEROBEL will serve as exclusive Belgian representative to market electronic, optical and mechanical systems and equipment produced by Fairchild for reconnaissance, mapping, data handling and ordnance applications. . . . *Simmonds Precision Products, Inc., Tarrytown, N.Y., has formed a wholly owned manufacturing subsidiary in England to produce electronic measurement, display, control and communications systems now being produced in the U.S. and The Netherlands.* . . . Electro-Tec Corp., Ormond Beach, Fla., has named Standard Telephones and Cables, Ltd., Harlow, Sussex, England, as exclusive sales distributor of Electro-Tec relays in the United Kingdom, Europe and the Near East. Standard is a subsidiary of International Telephone and Telegraph Corp.



This miniature frequency to d-c converter gives you all this:

Five models convert a-c input frequencies in ranges from 10-30 to 10-12,000 cps . . . to a proportional 0-5 volts d-c. The output is independent of waveform or signal level and regulated against changes in line voltage or ambient temperature.

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Compactness: Only 1.5 x 2.5 x 3.6 inches. 11 oz total weight. Threaded corner-holes for single or multiple mounting.

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For detailed specifications on the FR-320 Converter write for GS 1-7N3 D. The Foxboro Company, Van Nuys Division, 7740 Lemona Avenue, Van Nuys, California.

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36 Circle No. 7 on Subscriber Service Card

contracts and procurements

AWARDS

AIR FORCE

$4,659,304—**Aernspace Cnrp.,** El Segundo, Calif., to continue engineering and technical services for missile and space programs.

$3,901,000—**The Bneing Cn.,** Seattle, first increment of funds toward the design and development of a program for improvement of the *Minuteman* ICBM.

$3,395,860—**Labnratnry for Electronics, Inc.,** Boston, for continued production of radar system components.

$2,225,000—**Gentechnical Cnrp.,** Garland, Texas, for work on a classified project.

$1,721,000—**Knllsman Instrument Cnrp.,** Elmhurst, N.Y., for mapping and surveying system.

$1,550,725—**Lockheed Missiles & Space Cn.,** Sunnyvale, Calif., for work on *Agena* boosters.

$1,150,000—**Stearns-Rnger Corp.,** West Palm Beach, Fla., to make liquid hydrogen and LOX.

$1,000,000—**General Electric Cn.,** New York City, to study AF Mark XII re-entry system.

$350,000—**Aerojet-General Cnrp.,** Nucleonics Div., San Ramon, Calif., for additional facilities in support of AF exploratory development in high-temperature plasmas for space application.

$133,000—**Aerojet-General Nucleonics,** San Ramon, Calif., for additional facilities in support of AF exploratory development in high-temperature plasmas for space applications.

$118,583—**Hallicrafters Cn.,** Chicago, for aerospace ground equipment.

$86,400—**Aernspace Research, Inc.,** Boston, for airborne instrumentation to be used in Project Leap Frog.

ITT Cnrp., Federal Laboratories, Astrioncs Center, San Fernando, Calif., for experimental models of a new gas-bearing gyroscope for potential application to the development of a low-cost, long-life inertial guidance system for manned aircraft (amount undisclosed).

ARMY

$5,352,974—**Sperry Rand Cnrp.,** Salt Lake City, Utah, for modification of *Sergeant* missiles.

$2,220,000—**General Atrnnics Cnrp.,** Military Electronics Div., Philadelphia, for service test and procurement models of the AN/GSC-10 communication system.

$2,000,000—**Sperry Rand Corp.,** New York City, for previously rented classified electronic equipment.

$1,615,134—**Western Devices, Inc.,** Burbank, Calif., to furnish consoles, racks and cabinets for installation at the Launch Control Center, Vertical Assembly Building, Arming Tower and Pads A&B of Complex at the Merritt Island Launch Area, Fla.

$574,200—**Breeze Corp., Inc.,** Union, N.J., for powered target launcher supply items and support equipment.

$145,640—**Rncket Pnwer, Inc.,** Mesa, Ariz., for rocket motors.

$129,634—**Sanders Associates, Inc.,** Nashua, N.H., for field engineering services in connection with installation, repair and ground and flight checkout of the *Hawkeye* system.

$127,893—**Lear Siegler Inc.,** Astro Structures Div., El Segundo, Calif., for *Nike-Hercules* decelerator cylinder assemblies.

$85,972—**Hughes Aircraft Corp.,** Culver City, Calif., for 12-month investigation in the field of laser communications.

ITT Cnrp., Federal Laboratories, Astrionics Center, San Fernando, Calif., for experimental models of a new gas-bearing gyroscope for possible use in a low-cost simplified inertial guidance system for surface-to-surface ballistic missiles (amount undisclosed).

NAVY

$13,642.049—**General Dynamics Cnrp.,** Pomona, Calif., for continued work on the *Terrier-Tartar* program.

$10,000,000—**Lnckheed Missiles & Space Cn.,** Sunnyvale, Calif., letter of intent to provide up to $10 million for R&D on *Polaris* re-entry system.

$2,600,000—**Interstate Engineering Cnrp.,** Interstate Electronics, Anaheim, Calif., to supply two test instrumentation sets for the British *Polaris* weapon system.

$1,191,156—**Defense Electrnnics Inc.,** Rockville, Md., to make portable packages of shipboard instrumentation.

$650,000—**General Atrnnics Cnrp.,** Electronic Instrument Div., Philadelphia, for a production run of small transistorized oscilloscopes, electronic display devices used for test and information purposes.

$618,000—**Leach Cnrp.,** Los Angeles, for design, development and production of 18 magnetic tape instrumentation recorder/reproducer units designed to withstand rugged environments for shipboard applications.

$95,800—**System Develnpment Cnrp.,** Santa Monica, Calif., to conduct research on computer program development and control techniques.

$44,456—**Nnrthrop Cnrp.,** Norair Div., Hawthorne, Calif., to perform a study to define the design parameters for hydra-launched vehicles.

$42,770—**Rncket Pnwer, Inc.,** Mesa, Ariz., for rocket catapults.

$25,202—**Collins Radio Cn.,** Cedar Rapids, Iowa, for a telemetry system.

DEPARTMENT OF DEFENSE

$230,000—**Cnmputer Sciences Cnrp.,** El Segundo, Calif., for the design and development of a machine-independent ALGOL translator system which will permit computer users to prepare and execute programs for a variety of small, medium and large-scale machines.

NASA

$3,900,000—**Bechtel Cnrp.,** San Francisco, to manage the John F. Kennedy Space Center, mostly in the Merritt Island area, wbere facilities for the manned lunar landing program are being built.

$843,558—**Daltn Electronics Cnrp.,** Norwood, N.Y., for a real-time display system.

$420,000—**Martin Co.,** Orlando Div., Orlando, Fla., $372,000 for R&D on control signal processor equipment for the *Saturn* space booster; and $48,000 for an investigation of millimeter and far-infrared frequencies for potential use in space communications.

$269,746—**Martin Marietta,** Baltimore, for a conceptual study of a micro-meteoroid deep-space satellite.

$82,830—**Zimeny Corp.,** Monrovia, Calif., for *Trailblazer II* flight hardware.

$65,807—**Sperry Rand Cnrp.,** Electro-Optics Group, Great Neck, N.Y., for development and production of two miniaturized laser gyroscope systems.

$65,645—**Techninigy Engineer Cn.,** Brockton, Mass., for a high-vacuum thermal distortion chamber.

$35,896—**Spec.rnlab, Inc.,** Sylmar, Calif., for solar simulator spare parts.

$34,918—**Research Triangle Institute,** Durham, N.C., for a study of radiative energy transfer considerations for a re-entry vehicle with an absorbing and emitting boundary layer.

ITT Federal Laboratnries, Astrionics Center, San Fernando, Calif., to design, develop and make the fine guidance error sensors (FGES) for the *Aerobee* rocket program at Goddard Space Flight Center, Greenbelt, Md. (amount undisclosed).

NATIONAL SCIENCE FOUNDATION

$61,700—**Cnrnell University,** Laboratory of Atomic and Solid State Physics, Ithaca, N.Y., to continue Mossbauer Effect studies of the properties of solids and start Mossbauer measurements on a series of important biochemical substances.

INDUSTRY

$1,800,000—**Fairchild Space and Defense Systems,** Syosset, N.Y., from **McDnnnell Aircraft Cnrp.,** St. Louis, for production quantities of a multicamera, vertical stabilized mount.

$1,000,000—**Texas Instruments Inc.,** Dallas, from **Ling-Temcn-Vnught,** Dallas, for development of radars for the A-7A Navy light attack aircraft.

$1,000,000—**Raythenn Cn.,** Wayland, Mass., from **The Bneing Co.,** Seattle, to supply part of the electronic control system to be used in NASA's *Saturn V* rocket.

$100,000—**Fairchild Semiconductor,** Mountain View, Calif., from **Scientific Data Systems,** Santa Monica, Calif., for commercial integrated circuits.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Directorate of R&D Procurement
Systems Engineering Group, RTD
Wright-Patterson AFB, Ohio

Negotiations to be conducted with Southwest Research Institute, San Antonio, Tex., for continuation of research on mechanisms of friction and wear in high vacuum. RFP not available, for information only.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Virginia 23365

Negotiations will be conducted with General Applied Science Laboratories, Inc., for analytical study of aerodynamic means of controlling supersonic inlet flow. For information only, RFP not available.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058

Furnish personnel, facilities, equipment, and materials for investigation of low elasticity materials, associated fittings, and fabrication techniques for crew restraint systems. RFP BG721-82-5-45P—Due date Sept. 9, 1964. RFP available until Aug. 21 or exhaustion of supply.

Procurement and Production Office
R&D Contracts Div.
Laurence G. Hanscom Field
Bedford, Massachusetts 01731

Contract for research and development to investigate the application of angular dispersion and compression techniques to antenna design to be negotiated with Philco Corp., Blue Bell, Pa. For information only, RFP not available.

National Aeronautics and Space Administration
Langley Research Center
Langley Station
Hampton, Virginia 23365

An amendment will be negotiated with Ling-Temco-Vought, Inc., Dallas, for an extension of a *Scout* motor performance analysis and prediction study. For information only, no RFP available.

Systems Engineering Group
Research and Technology Division, SEKNB
Wright-Patterson AFB, Ohio

Contract for the design fabrication test qualification and delivery of a minimum reaction space power tool for experimentation on *Gemini* to be negotiated with Martin Marietta Corp., Baltimore. For information only, RFP not available.

Directorate of R&D Procurement
Systems Engineering Group, RTD
Wright-Patterson AFB, Ohio

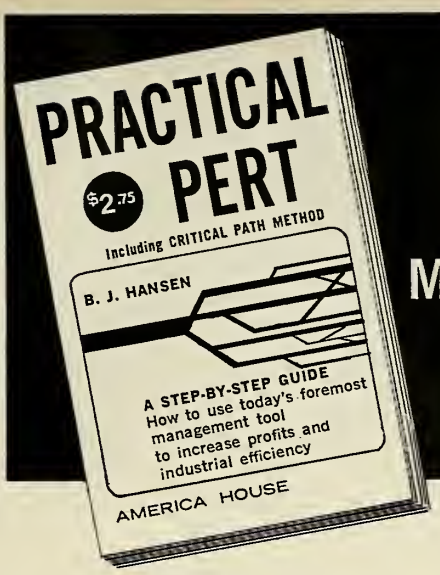
Negotiations to be conducted with ITT Research Institute for continuation of research study of vortex flow in ducts. For information only, RFP not available.

Directorate of R&D Procurement
Systems Engineering Group, RTD
Wright-Patterson AFB, Ohio

Negotiations to be conducted with Atlantic Research Corp., Alexandria, Va., for continuation of research and development on advanced slurry fuels. For information only, RFP not available.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Texas 77058
Attn: Aubin O. Ferguson

Two parallel contracts are contemplated for a manned spacecraft systems cost model study. RFP BG751-39-5-28P, due date Sept. 8, 1964.



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III PERT & TIME
IV HOW PERT PLANS
V HOW PERT CONTROLS
VI BUILDING PERT
VII WHAT IS NETWORKING
VIII REFINING THE NETWORK
IX MEASURING MANAGEMENT RISK
X PERT & COST
XI PROFIT PERT & INCENTIVES
XII PERT DATA DISPLAY

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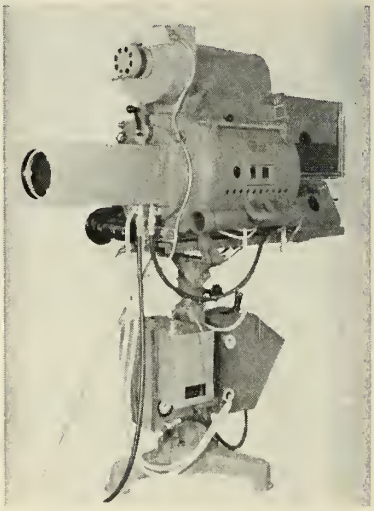
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New Product of the Week: Solar Radiation Simulator

A solar radiation simulator designed for testing space vehicles 4 ft. in diameter or larger in vacuum chambers is being marketed by Genarco, Inc.

The Model ME6CWM produces a lightbeam characteristic of sunlight in the outer atmosphere. Source of radiation is a 400-amp carbon arc lamp with the same spectrum as the surface of the Sun. The optical system is made of fused quartz which has a flat transmission over the whole spectrum. A zoom optical device provides an increase or reduction of radiation intensity without changing the spectrum. A positive carbon magazine that feeds and joins the carbons automatically enables the arc lamp to operate continuously for long periods of time.



Circle No. 151 on Subscriber Service Card

Temperature System

A controlled temperature system to life-test or age power devices or packaged circuits at selected temperatures is being marketed by Aerotronic Associates, Inc.

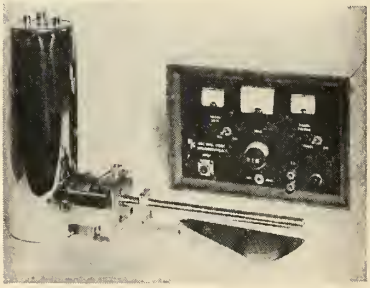
Through liquid-bidirectional heat transfer, it can heat or cool, maintaining temperatures to ± 1°C with a 1,000-watt load. With the use of coated transfer heat sinks, it may be used to test devices requiring electrical isolation. The basic units are available in two temperature ranges: 25° to 100°C or 75° to 150°C. Complete systems will be designed to customer specifications.

Circle No. 152 on Subscriber Service Card



X-Ray Diffraction Chamber

An X-ray diffraction chamber that provides sample temperatures as low as 4.2°K in vacuums to 10^{-5} torr has been developed by MRC Manufacturing Corp.



In the Model X-86-NC, solid or powder samples measuring up to ½ x ½ x ⅛ in. are mounted on a holder in contact with a liquid helium cryoflask. The cryoflask will hold temperature levels for up to 4 hrs. using 0.4 liters of liquid helium. Temperature flexibility is accomplished by a resistance heater built into the specimen holder.

A 10-mil, curved beryllium window permits a diffraction angle of 0 to 160 degrees while reducing X-ray intensity by less than 10%.

Circle No. 153 on Subscriber Service Card

Silicon Rectifier Diodes

Westinghouse Electric Corp.'s Semiconductor Div., has available a series of silicon rectifier diodes, the Type 400, JEDEC series IN3288.

With proper cooling, the units can provide forward currents up to 125 amps with maximum reverse voltage ratings up to 1,000v peak. The hermetically sealed diodes have a maximum half-cycle surge current under load of 3,000 amperes peak. They are available with forward or reverse polarity and have a junction operating temperature range from −65° to 200°C.

Circle No. 154 on Subscriber Service Card

Pulse Counter

Parabam, Inc., is marketing the Model 60 plus/minus pulse counter, designed for use in process control, machine tool control, data reduction, programming and instrumentation.



The solid-state unit accepts dual channel input pulses at rates up to 10,000 cps having minimum signal of 2v RMS. It automatically adds, substracts, senses zero and reverses direction to either plus or minus count. It is available in 3 to 6-decade models and has decimal coded output of 6v dc at 250 ma. Other output formats are available.

Circle No. 155 on Subscriber Service Card

Laser Demonstration Kit

A gallium-arsenide laser demonstration kit—including laser, pulser and dewar—is being marketed by Korad Corp., subsidiary of Union Carbide Corp.

The laser has a guaranteed peak power of 1 watt with 1-microsec. pulse width at 40 amps. The system operates from a 110-v, 60-cycle ac source and utilizes about ½ liter of liquid nitrogen for approximately 6 hrs. of operation.

The pulser has a pulse rate of up

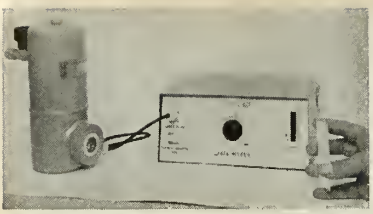


Species Pisces. Sperry is no stranger to the seas. We have hunted ASW answers since WWII days, and have been at it steadily since 1949. Now on the seas are the Sperry MK18 Angle Solver, retrofitted to older vessels for modern fire control...the MK112 Fire Control Computer System for target analysis from subs... PUFFS and PADLOC sonar systems. ASW sonar is a discriminating listener which translates and classifies what it hears. We're working constantly to improve these abilities. Also under study are torpedo countermeasures; detection, tracking, classification techniques; transducers for great depths; sonar navigation; underwater communications; optical data processing; oceanography; and various research and test programs of the undersea species.

INFORMATION & COMMUNICATIONS DIV., Sperry Gyroscope Co., Great Neck, N. Y.

SPERRY
DIVISION OF
SPERRY RAND
CORPORATION

Circle No. 8 on Subscriber Service Card



to 3 kc with a 1-microsec. pulse width at 0 to 60 amps. The injection laser used in the kit has a threshold current density of less than 2,000 amperes/cm^2. Emission is approximately 8,400Å with a linewidth of 8Å at threshold.

Circle No. 156 on Subscriber Service Card

Multi-Tap Delay Line

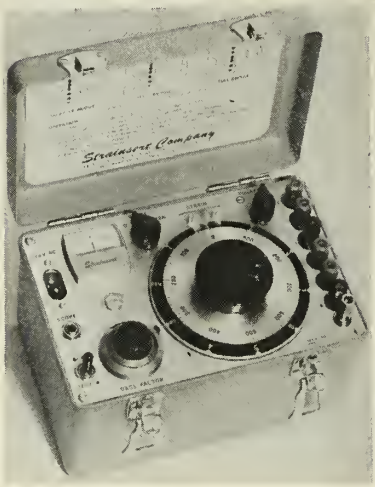
A high bandpass delay line, said to be ideal for low frequency and sonar use, has been introduced by Computer Devices Corp.

The Model DA 607 has 250 taps spaced at 80-microsec. intervals to give a total delay of 20 millisecs. Phase linearity is within ± ¼% up to 2.5 kc and ± 1% up to 3.5 kc. VSWR is less than ± 1 db up to 3.5 kc. Insertion loss is less than 2 db at any tap point. Impedance is 560 ohms.

Circle No. 157 on Subscriber Service Card

Portable Strain Indicator

Strainsert Co. is marketing a portable strain indicator with a square wave carrier circuit that makes it insensitive to lead wire capacitance. It is designed to allow over 0.01 microfarad of disturbed capacity with practically no loss of sensitivity or accuracy.



The instrument is a null-balance type, accurate to 0.1%. It will accept all standard strain gage circuitry with resistance values from 50 to 2,000 ohms. Gage excitation voltage is approximately 1.5v. Range is ± 30,000 microstrain. Gage factor range is continuously variable between 1.5 and 4.5.

Circle No. 158 on Subscriber Service Card

Bar-Graph Oscilloscope

A bar-graph oscilloscope for use with telemetry displays is available from ITT Industrial Products Div.

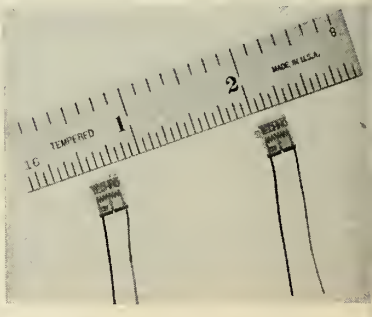
The solid-state Model KB-703 displays up to 100 channels of data presented at calibrated vertical bars on a 17-in. cathode ray tube. Maximum input sensitivity is 1v for full-scale deflection.

Circle No. 159 on Subscriber Service Card

Wirewound Trimmer

Techno-Components Corp. has introduced a multi-turn ¼-in. square wire-wound trimming potentiometer, the Series 10.

The units have an adjustment ratio of 25:1 at resistance values from 100 to 30 K ohms with a ± 5% tolerance. They are available in four configurations: side and top adjust with weldable printed circuit pins and side and top adjust with stranded teflon leads.



The series is rated for ½-watt at 50°C, derating to 0 at 175°C. Operating temperature range is —55° to 175°C.

Circle No. 160 on Subscriber Service Card

Tuning Fork

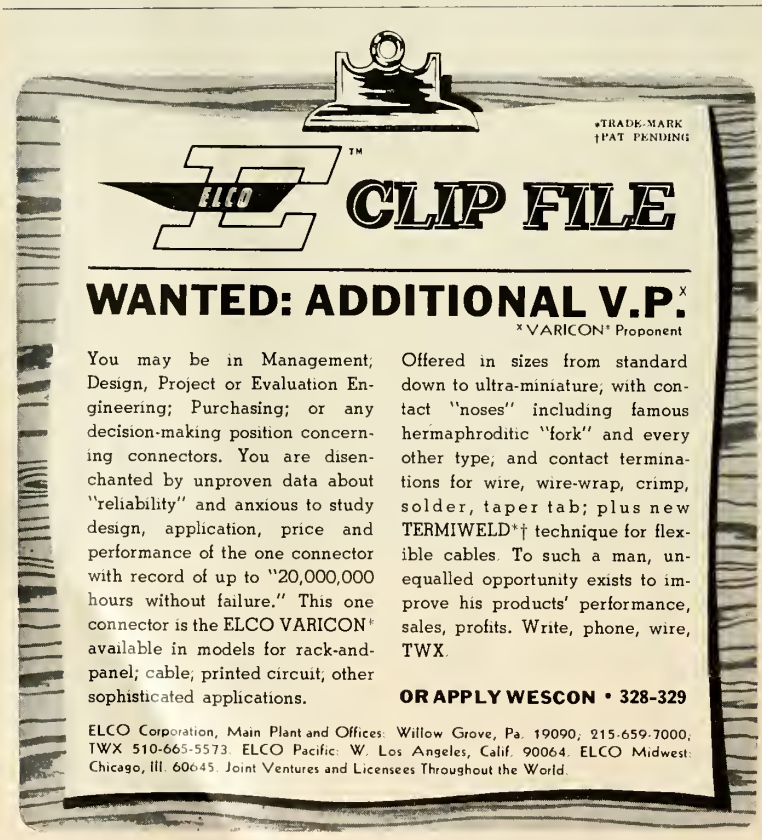
A subminiature tuning fork with a frequency range of 800 to 3,200 cps and accuracies of ± 0.2 to 0.05% is available from the Gyrex Corp.

The Model 264 operates in a temperature range of —55° to 100°C. Operating life is 10,000 hrs. minimum. The unit measures ⅜ in. in diameter and 1⅞ in. long. Weight is 22 grams nominal.

Circle No. 161 on Subscriber Service Card

Digital/Analog Converter

Abacus, Inc., has announced a digital-to-analog converter that accepts 2 decades and sign BCD input and per-



Circle No. 9 on Subscriber Service Card

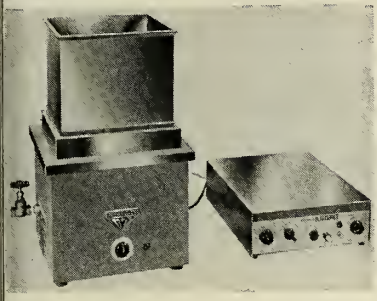
forms 200,000 conversions per second with 0.4% accuracy.

The Model EDA-20 is available with output of 0 to —10v or 10 to —10v. Optional equipment includes digital hold registers, absolute magnitude and sign and output operational amplifiers.

Circle No. 162 on Subscriber Service Card

Ultrasonic Cleaning System

An ultrasonic cleaning system consisting of a transducerized heated tank, vapor condensing jacket and ultrasonic generator has been introduced by Blackstone Corp.

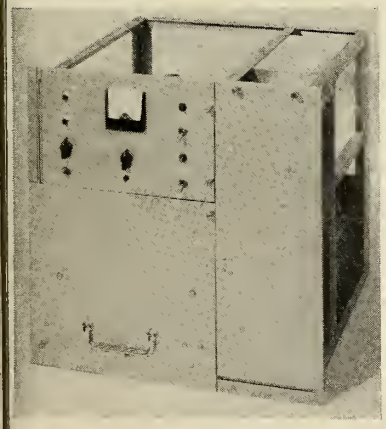


Commonly used vapor degreasing solvents can be selectively heated between 70° and 230°F for the cleaning process. The single tank is 12 x 12 x 6 in. and has a removable water-cooled condensing jacket which provides for both dip cleaning and vapor rinsing.

Circle No. 163 on Subscriber Service Card

Storage Tube System

Image Instruments, Inc., has developed a solid-state single-gun recording storage tube system for radar, television, process control and digital computer applications.

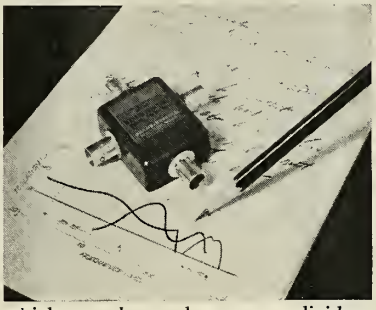


The Model 221 Electrostore has an 800-kc deflection bandwidth and is capable of resolving 1,000 lines across the diameter of the stored picture.

Circle No. 164 on Subscriber Service Card

Broadband Hybrids

Adams-Russell Co., Inc., has available a series of broadband hybrids,



which may be used as power dividers, balanced mixers or duplexers.

Four models cover the frequency ranges of 2 to 32 mc, 20 to 200 mc and 200 to 400 mc. The units weigh 2½ oz. and are 2 cu. in. in volume.

Circle No. 165 on Subscriber Service Card

Self-Fueling Welder

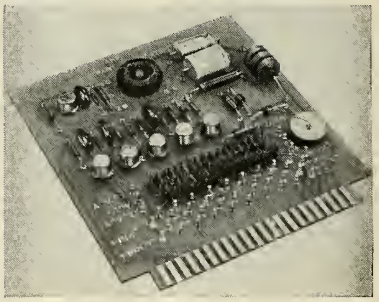
An oxy-hydrogen welding system capable of generating its own fuel at a rate of over 20 cu. ft./hr. has been announced by Henes Manufacturing Co.

The Model "L" water welder uses distilled water as the fuel source, dissociating it to hydrogen and oxygen. Combustion of the gases provides flame temperatures as high as 6,000°F. Included in the system is a booster tank that uses methyl alcohol vapor to reduce flame temperature while increasing BTU output.

Circle No. 166 on Subscriber Service Card

Binary Sequence Detector

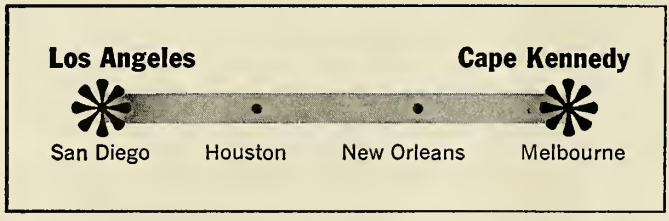
AMP, Inc., has available a 16-bit binary sequence detector that uses ferrite cores and wire only. The miniature solid-state device can be wired to detect any single 16-bit lock word occurring in a random code stream and is capable of detecting every sequence of 2^{16} combinations



Specifications include a voltage range of 24 to 32v dc; temperature range of —50° to 75°C; average current at 1-kc bit rate, 40 ma maximum at 28v.

Circle No. 167 on Subscriber Service Card

What's the shortest distance between these 2 points?



National's direct line.

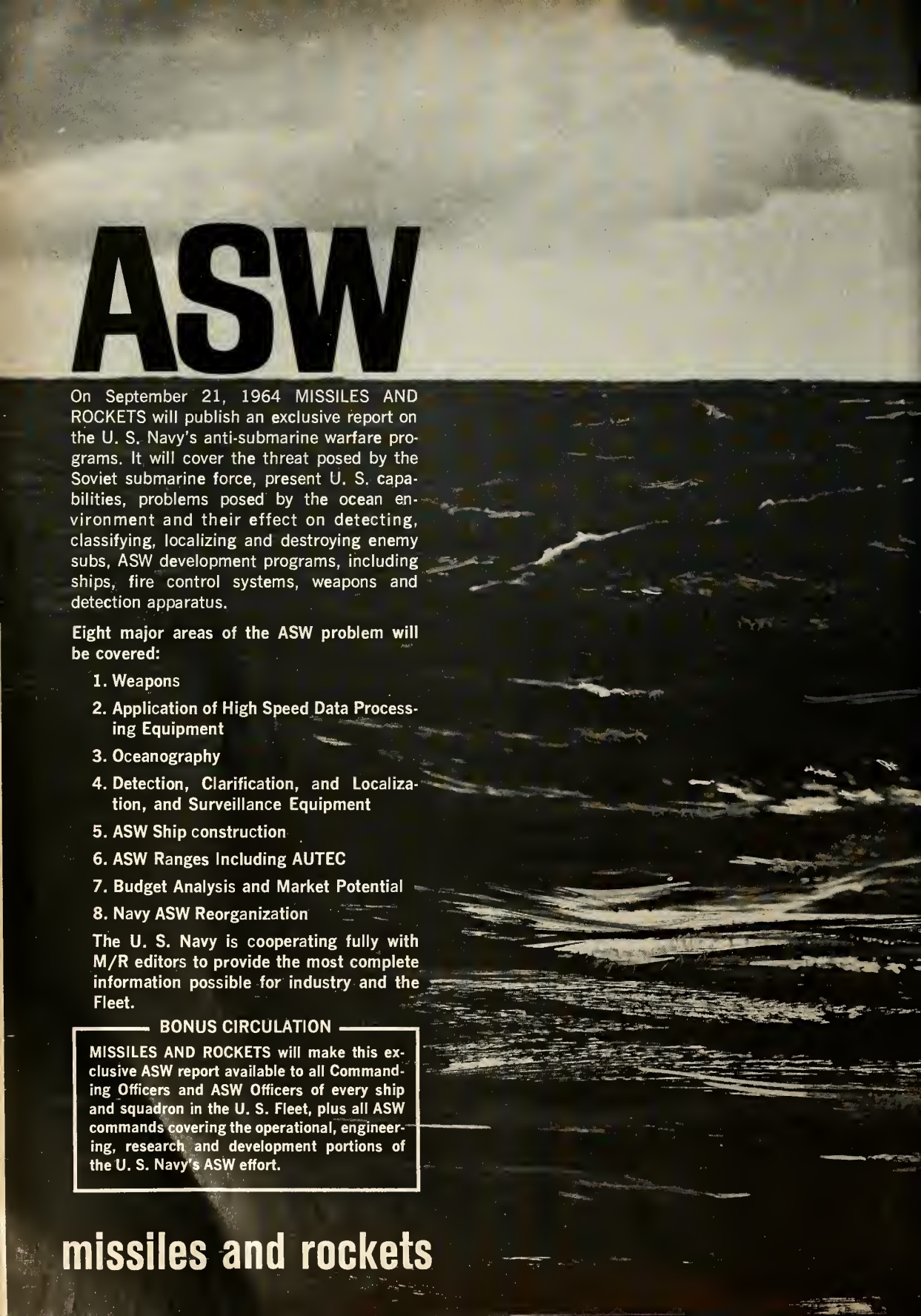
We call it our "Rocket Run." It's the only direct jet service between the major space centers of the west and Melbourne (closest airport to Cape Kennedy.)

You jet between Los Angeles and Melbourne without changing planes. National also serves the key space age cities along the east coast.

Is this any way to run an airline? You bet it is.

Jet National
coast to coast to coast

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ASW

On September 21, 1964 MISSILES AND ROCKETS will publish an exclusive report on the U. S. Navy's anti-submarine warfare programs. It will cover the threat posed by the Soviet submarine force, present U. S. capabilities, problems posed by the ocean environment and their effect on detecting, classifying, localizing and destroying enemy subs, ASW development programs, including ships, fire control systems, weapons and detection apparatus.

Eight major areas of the ASW problem will be covered:

1. **Weapons**
2. **Application of High Speed Data Processing Equipment**
3. **Oceanography**
4. **Detection, Clarification, and Localization, and Surveillance Equipment**
5. **ASW Ship construction**
6. **ASW Ranges Including AUTEC**
7. **Budget Analysis and Market Potential**
8. **Navy ASW Reorganization**

The U. S. Navy is cooperating fully with M/R editors to provide the most complete information possible for industry and the Fleet.

BONUS CIRCULATION

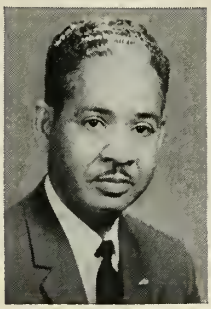
MISSILES AND ROCKETS will make this exclusive ASW report available to all Commanding Officers and ASW Officers of every ship and squadron in the U. S. Fleet, plus all ASW commands covering the operational, engineering, research and development portions of the U. S. Navy's ASW effort.

missiles and rockets



Publication Date: September 21, 1964
Closing Date: September 7, 1964


WOLFSON


MARCHBANKS


EGGERS


LUX


ATWOOD

William Wolfson: Appointed to the new position of senior vice president for Corporate Development at Computer Control Co., Inc., Framingham, Mass.

Vance H. Marchbanks, Jr.: Appointed chief of environmental health services for the Hamilton Standard Div. of United Aircraft Corp., Windsor Locks, Conn. He will have charge of all medical and safety aspects connected with manned testing and evaluation of pressure suits and other personal equipment designed for space flight.

Robert F. Eggers: Joined Rocket Research Corp., Seattle, Wash., as chief of Hydrazine Rocket Engine Development. He was formerly with Aerojet-General Corp. where he worked on the decomposition of hydrazine. **Charles J. Green** has also joined Rocket Research as chief of Rocket Propellant System Development. He was formerly head of Propulsion Technology for the U.S. Naval Ordnance Test Station at China Lake, Calif.

John H. Lux: Elected a member of the board of directors of Hercules Powder Co., Wilmington, Del. He will continue as president and a member of the board of Haveg Industries, Inc., a new subsidiary of Hercules.

John G. Atwood: Named to head research activities, Electro-Optical Div., Perkin-Elmer Corp., Norwalk Conn. He will assume responsibility for the solid-state materials group, the research branch of engineering, the optical maser department and the scientific computing facility.

Hugh E. Witt: Elected national president of the Armed Forces Management Association. He is Deputy Assistant Secretary of the Air Force for Supply and Maintenance.

Robert B. Voas: Appointed director of the Life Sciences Lab of the Guidance and Control Systems Div. of Litton Industries, Santa Monica, Calif. The Life Sciences Lab is a newly created department at Litton, and was formed to handle research in man-protection systems. Voas formerly was assistant to the director of NASA's Manned Spacecraft Center, Houston, Tex.

Ralph W. James: Appointed member of the Board of Directors of Marshall Industries, San Marino, Calif.

G. O. Moore: To head the new Deep Space Programs Office of Philco Corporation's Western Development Labs Div., Palo Alto, Calif. He was formerly program manager of WDL's Communication Satellite Program Office. This position now will be held by **Fred D. Kochendorfer,** former manager of Advanced Systems and Programs. **Robert O. Fickes:** To become president and chief executive officer of Philco Corp., Philadelphia. He is succeeding **Charles E. Beck,** who will now be staff executive, General Products Group, Ford Motor Co.

John A. Morris: Named vice president of manufacturing at Dynatronics, Inc., Orlando, Fla. The position is a newly created post in the firm.

A. H. Garry Gibson: Named to new post of advanced systems program director in the Control/Nucleonics Div. of Giannini Controls Corp., Duarte, Calif.

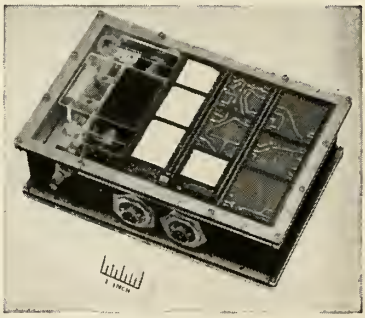
Harry E. Mottley, Jr.: Joined General Instrument Corp., New York City, as Corporate Director of Reliability.

Edward J. Garrett: Elected president and chief executive officer of Instrument Systems Corp., Westbury, N.Y. ISC designs and manufactures electronic, electromechanical, and communications products.

EIMAC

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This 2-watt transmitter uses a triode-cavity power oscillator to achieve higher overall efficiency than is possible with all-solid-state transmitters. Frequency stability is achieved by an AFC servo loop referenced to a crystal oscillator. Tuning range is 2.2-2.3 Gc. Total volume is 50 cubic inches. Modulation linearity (maximum deviation from best straight line) is ±0.5% from ±10 Kc to ±300 Kc, and ±2.5% from ±10 Kc to ±1.5 Mc. Amplitude modulation is less than 5%. Susceptibility requirements of MIL-I-26600 are met. The solid state power supply operates from 28±4 Vdc with over 80% efficiency.



For complete information on this transmitter, contact Eitel-McCullough, Incorporated, San Carlos, California. In Europe contact Eitel-McCullough, S. A., Geneva, Switzerland.

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AUGUST

Elementary Nuclear Magnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 17-19.

Tenth International Symposium on Combustion, Combustion Institute and Cambridge Physical Chemistry Dept., Cambridge Univ., Cambridge, England, Aug. 17-21.

International Astronomical Union Symposium No. 25, AFOSR, International Astronomical Union, Government of Greece, and Univ. of Thessaloniki, Thessaloniki, Greece, Aug. 17-22.

Ninth Annual Showing of Advanced Electronic Research Projects, sponsored by Stanford Electronics Laboratories, Stanford Univ., Stanford, Calif., Aug., 18-21.

Elementary Electron Paramagnetic Resonance Workshop, sponsored by Varian Associates, Analytical Instrument Div., Palo Alto, Calif., Aug. 19-21.

Conference on Interference and Coherence, International Commission for Optics and Australian Academy of Sciences Sydney, Australia, Aug 24-25.

Nineteenth National Conference sponsored by Association for Computing Machinery, Sheraton Hotel, Philadelphia, Aug. 25-27.

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, Aug. 24-26.

Fourth Congress of the International Council of the Aeronautical Sciences, International Council of the Aeronautical Sciences and AIAA, Paris, Aug. 24-28.

"Graphic Techniques for Computation," sponsored by the Univ. of California Extension Center, San Francisco, Aug. 24-Sept. 4.

"Nuclear Education in the New Era of Nuclear Power," sponsored by Oak Ridge National Laboratory, Oak Ridge Institute of Nuclear Studies, and U.S. Atomic Energy Commission, Div. of Nuclear Education and Training, Gatlinburg, Tenn., Aug. 25-28.

1964 International Congress for Logic, Methodology and Philosophy of Science, and International Colloquium on Algebraic Linguistics and Automata Theory, sponsored by AFOSR, AFCRL, ONR, ARO, and International Union for History and Philosophy of Science, Hebrew Univ., Jerusalem, Israel, Aug. 25-Sept. 2.

12th General Assembly, International Astronomical Union, Univ. of Hamburg, Hamburg, Germany, Aug. 25-Sept. 3.

Gravity Day, sponsored by the Gravity Research Foundation, New Boston, N.H., Aug. 29.

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The Calculated Truth

WITHOUT QUESTION, the nation's defense and space policies will be major issues in the 1964 Presidential campaign. The initial barrages in this area have already been exchanged.

It will be the policy of this magazine during the campaign to provide coverage of significant statements by either candidate which directly concern the missile/space industry. If these statements differ from the known facts, we may from time to time point this out. The goal of our coverage will be objective and non-partisan reporting. We do not intend, even on the editorial page, to take a stand favoring either candidate. We believe this goes beyond the traditional function of a trade journal.

We already are concerned by the tendency of both the Administration and the Republican candidate to play somewhat loosely with the facts about the nation's defenses. It is not our contention that the defense of the United States should not be a campaign issue.

We do believe that inaccurate and irresponsible statements can do irreparable harm to the credibility of U.S. defenses.

The greatest danger in a heated campaign involving honorable men lies not in falsehood, but in exaggeration and half-truth. The questionable news management policies of the present Administration and the tendency to easy generalization on the part of the Republican candidate already have provided unpalatable examples of this. We urge both parties to give strong, new consideration to the damage that may be caused.

Sen. Barry Goldwater's charge that the U.S. deliverable nuclear capability may be cut by 90% under present Administration policies is totally unsupported. Even when semantic differences between deliverable capability and number of warheads are discounted, the Senator's charge must be regarded as questionable unless he can offer evidence to support it.

By the same token, the reply of Assistant Secretary of Defense Arthur Sylvester on behalf of the Department of Defense is considerably less than candid. His effort to claim for the present Administration the entire credit for deployment of the *Atlas, Titan, Polaris* and *Minuteman* forces falls far short of the facts. Development and funding of the *Atlas* and *Titan* missiles was carried out almost entirely by the Eisenhower Administration. One of President Kennedy's first moves after taking office was, in fact, to cut two full *Titan II* squadrons from the program. Both *Polaris* and *Minuteman* were initiated by the preceding Administration, although the incoming office holders did increase the pace and numbers of these programs.

This is not to argue the merits of these decisions, but to point out that Mr. Sylvester was distorting things somewhat with his claim that "we have added more than 200 *Atlas* and *Titan* ICBM's to the force," with no further amplification of just where the initiative was in those programs.

The Administration's position on the four ICBM programs has been a sound one and there is no need to overstate it, as Mr. Sylvester did in his eagerness to counter Sen. Goldwater's questionable charge.

IN FACT, THE CREDIBILITY of news issued from the Dept. of Defense has been opened even wider to question by the lack of candor during the Viet Nam crisis.

President Johnson during his initial telecast concerning the air strikes against North Viet Nam left the distinct impression that the attacks already were under way. Secretary of Defense McNamara told a press conference at 12:02 a.m. EDT, August 5: "I can tell you that some of that action already has taken place. U.S. naval aircraft from the carriers Ticonderoga and Constellation, these carriers operating in the Gulf of Tonkin where our destroyers had undergone two deliberate attacks in international waters, have already conducted air strikes against the North Vietnamese bases from which these PT boats have operated."

QUESTION: Can you tell us if the attack is currently under way?

SECRETARY MCNAMARA: It is currently under way.

There was nothing unequivocal about these statements. Yet a Pentagon press summary subsequently showed the attack occurred at 1:15 a.m. EDT, August 5, more than an hour after the Secretary's statement and an hour and a half after the President's telecast.

A lame Pentagon explanation of the discrepancy, issued on Aug. 7, included these points:

- By that time (the President's telecast at 11:40 p.m.) U.S. naval aircraft had been in the air on their way to their targets approximately one hour. (This would indicate a flight time of 2 hrs. 35 mins. to hit targets which at the most were within 400 miles of the carriers and probably closer, figures oddly inconsistent with the aircraft employed.)
- Hanoi, through its radar, had then (when the President spoke) received indications of the attack. (Not only did this fail to explain how the U.S. knew what Hanoi learned through its radar, it also conflicted directly with the statement of task force commander Rear Adm. Robert B. Moore that he did not think his planes were viewed by Communist radar before their mission was announced.)
- The time remaining before the aircraft arrived over their targets was not enough to permit the North Vietnamese to move their boats to sea or to alert their forces. (Yet a flight leader told newsmen aboard the carrier that torpedo boats at one harbor already were dispersing to sea when the planes appeared. Others reported heavy antiaircraft fire on the first strikes.)

Unless the Pentagon can clear up these inconsistencies—including its failure to explain until trapped the pre-announcement of the strikes—the impression must remain of an incredible military blunder.

Politics or no, just the facts, gentlemen—from both sides.

William J. Coughlin

Systems Analysts & Preliminary Design Engineers for Advanced Space Guidance & Control Systems

Rapid expansion of space contracts, projects and studies at the HUGHES Aerospace Divisions in Southern California has created unusual opportunites for several qualified Engineers, Physicists and Mathematicians for Advanced Space Systems assignments.

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- **RENDEZVOUS & RE-ENTRY GUIDANCE**

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To study and develop guidance and navigation equations and techniques; make feasibility and error analyses; establish subsystem and component requirements; conduct system preliminary design; plan inertial, optical and electro-magnetic instrumentation.

Control System Synthesis

To analyze control system requirements for various space vehicles; establish subsystem and component requirements; conduct system preliminary design; study measurement instrumentation and torque-producing equipment.

Simulation

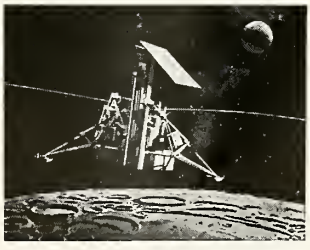
To plan digital simulation for studies related to earth orbital, trans-lunar, interplanetary and reentry trajectories; analog simulation of rendezvous guidance and control systems.

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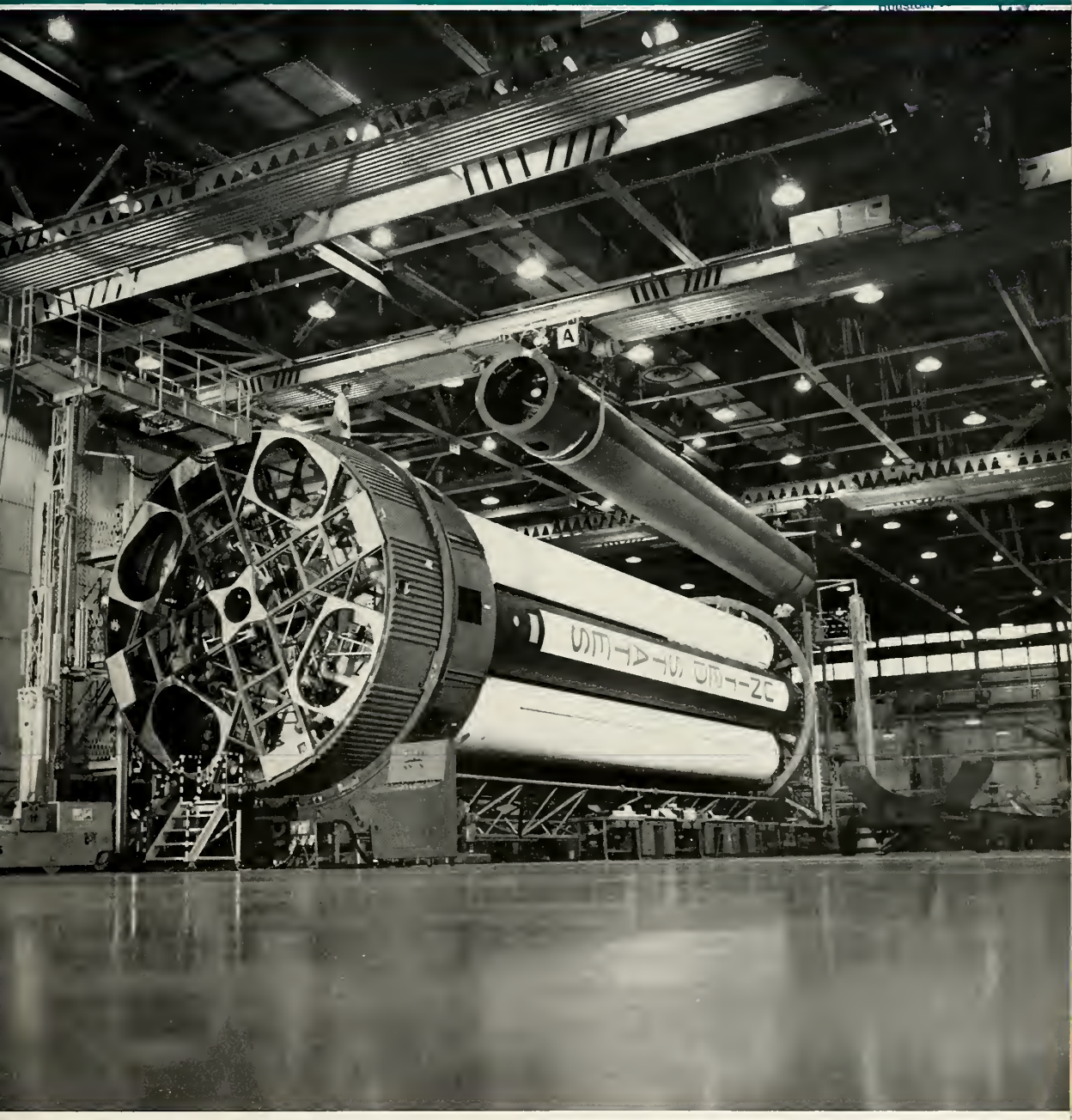




AUGUST 24, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



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GEMINI TRACKING SYSTEM

canoga

NASA's Goddard Space Flight Center, Greenbelt, Md., selected Canoga's new TELTRAC systems to acquire and track the Gemini vehicle as it comes over the horizon, aim the primary tracking radar and receive telemetry data. TELTRAC, a complete passive telemetry tracking system, containing a new crossed dipole antenna array, an updated standard Canoga pedestal system, and a monopulse tracking receiver, is one of a number of instrumentation range tracking systems designed and manufactured by Canoga. It will supplement the Project Mercury tracking systems with a more up-to-date system capable of acquiring and tracking any IRIG telemetry signal within the range from 215 to 260 mc/s.



Of particular interest in this new TELTRAC system is the TELAR antenna developed by Canoga. This unique array comprising 12 crossed dipole elements on a 13-foot octagonal ground screen, can be remotely switched to horizonal, vertical, LH, or RH circular polarization, and attains very low side lobe levels (more than 20 db down) to minimize multipath and RFI signal interference. TELTRAC Systems offer maximum installation flexibility—mobile, ground based or shipboard. For more information on TELTRAC including models for other frequency ranges and other tracking systems, contact Canoga for descriptive literature.



Engineers and Scientists: A number of key openings exist at Canoga in the fields of Radar, Telemetry, Trackers and Antenna Design and Development. Call or send resumé to J. McCann, Vice President.

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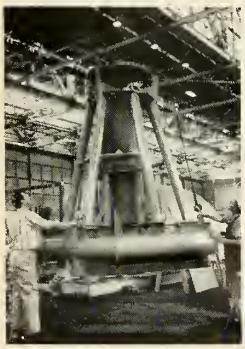


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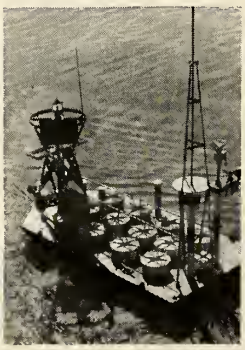


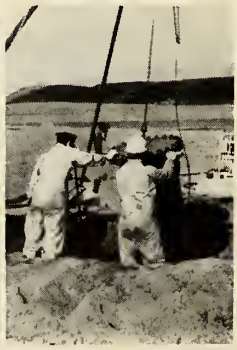


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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 15, Number 8 August 24, 1964

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THE COVER



One of the last of eight clustered 70-in.-dia. fuel tanks is lowered into position on the first Saturn S-IB booster stage built by Chrysler Corp.'s Space Div. for NASA at the space agency's Michoud Operations, La. The stage will have a total of 1.5 million lbs. of thrust.

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46,800 copies this issue

SATELLITE

Today, the big word in satellites is "synchronous." The first was NASA's Syncom—just chalking up a full year of failure-free service. Its sister—"Public Satellite #1"—will bring Europe close as your phone, let you see even the longest overseas TV programs "live" and uninterrupted.

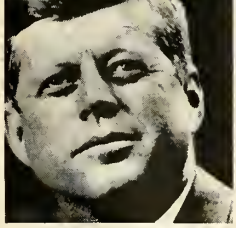
There was more than a little skepticism in 1959 when Hughes engineers began work on a synchronous satellite. The problem was to boost a satellite to a precise altitude of 22,300 miles and position it so it would travel with the earth's rotation — in effect "stand still" over a point on earth.

Each such "star" would be in constant sight of a third of the earth. Since it remains "parked" it could beam signals to and from the inexpensive type of ground stations which have stationary antennas. These will be affordable probably by all nations with the need. The net result: uninterrupted, 24-hour intercontinental communications. Improved telephone, wireless, wirephoto and TV communications would not be the only benefits. Other uses might include: instant inventory control on global basis, truck to truck military field communications, aircraft flight control, navigation and meteorology.

Thus, a great deal rode on Syncom when it was launched on July 26, 1963. But in the year since, skepticism has all but evaporated. Syncom has transmitted the voices of thousands of people and other kinds of signals for over 2,500 hours. It has set a record of more than twice the communication time logged by other satellite types. An almost incredible series of space feats occurred, too. After arriving at launch altitude over the Indian Ocean, Syncom was "walked" halfway around the world to a six-month stay over Brazil and recently was taken for another "walk" to its present position over the Pacific.

These achievements helped bring the first truly global communications system closer to reality when the Communications Satellite Corporation chose a Syncom-type satellite to be "Public Satellite #1." Any American will be able to make a call via "Early Bird's" facilities. It will almost double present trans-Atlantic telephone capacity; while being instantly ready to bring you historic TV programs from overseas.

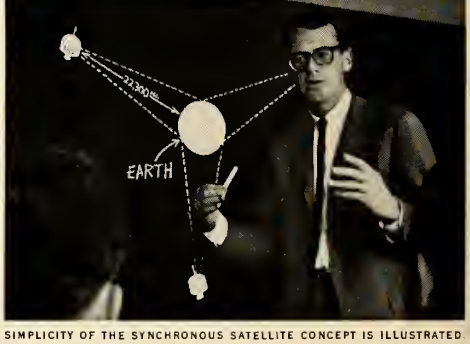
Hughes is also active in other areas of the technology. One of these — ground stations—can be available when needed. Hughes is now under contract to NASA to further extend man's knowledge of space with Advanced Technological



UNRETOUCHED PHOTO OF PRESIDENT KENNEDY SENT VIA SYNCOM LAST SUMMER DURING THE HISTORIC EXCHANGE OF PHOTOS WITH PRESIDENT AZIKIWE OF NIGERIA.



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SIMPLICITY OF THE SYNCHRONOUS SATELLITE CONCEPT IS ILLUSTRATED. POSITIONED AT AN ALTITUDE OF 22,300 MILES, ONE OPERATING SYNCOM-TYPE SATELLITE CAN COVER A THIRD OF THE EARTH.

SYNCOM UNDERGOING CHECKOUT (RIGHT) BEFORE LAUNCH A YEAR AGO. NOT ONE OF ITS 2,000 PARTS HAS FAILED — RELIABILITY WHICH HAS ENABLED IT TO BREAK COMMUNICATIONS SATELLITE RECORDS.

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letters

Poor Man's Rocket

To the Editor:

Constructing rocket motors out of paper (M/R, July 20, p. 28) offers unheard-of possibilities for economy—something of special interest in view of a possible Goldwater administration. The ideal "poor man's rocket" is one priced within the range of private groups. And the economies will not stop there, since the requirements and standards will not have to be so high with such groups. Paper or other consumable material is a long step in that direction because it can be burned through to a very thin shell, leaving almost no dead weight, so that the fuel and oxidizer tanks can be placed inside the motor and the natural boiloff used to supply the combustion. This would be impracticable with a metal casing because of the large size and great weight of such a chamber, the need for thermal insulation or cooling systems, jettisoning of dead weight, etc. But a boil-off-feed consumable motor operating with decreasing pressure with the emptying of the tanks would eliminate at a single stroke nearly all the complications of the ordinary rocket.

It is the casting, curing, chemical balancing, elimination of cracks, porosity, etc., on the one hand, or forcing the propellants in against the back pressure of the gases, on the other, not the price of the ingredients and materials themselves, that runs up the costs. And the narrow tolerances inherent in such systems, and budgetary reduction in size and number of payloads. But the latter so increases the element of risk as to require expensive instrumented probes prior to any manned mission. A really simple and inexpensive thrust system, on the other hand (described in my July 15 letter in M/R), would render versatility in survival equipment, in-course maneuvering to compensate for inaccuracies in guidance, and speedy organization of rescue missions a simple matter.

Theodore B. Dufur
Los Angeles

Ranger Rebuttal

To the Editor:

I am enclosing a copy of your Feb. 10 editorial, "A $150-Million Failure," concerning the *Ranger* program through *Ranger VI*. It has been carefully preserved for this auspicious occasion. Recent events now permit its return to the author for rumination and consumption. (Many have hoped the recipient would choke on it.) As surely as the ideas it expressed were ill-considered and inappropriate upon their appearance, so also was it certain that the time for rebuttal would come swiftly. Even so, the opportunity to reply was not really expected quite this soon.

By anybody's standards, *Ranger VII* was an unqualified success. Those associated with the mission could find no way to improve upon it. Thus it would seem, by your own definitions and devious logic, that the entire program, now costing some $200 million, must similarly be classified a success. Does this refute the notion to "avoid sending good money after bad"? It appears $50 million more has helped the older $150 million.

And what do you say now of the competence of the program's management? Look also to the preponderance of more costly "industrially managed" projects that never even made it to the launch pad, much less lifted-off. If JPL is guilty of maladministration, it is due to the fact that it stands up to be counted as ready and willing to "light the punk" and prove that the requirements and objectives have been met and exceeded. The mantle of responsibility and the exercise of authority are well placed. Where else can the nation obtain such genuine dedication and zeal in the achievement of excellence?

Please do not attempt to imply that the recent criticism from many sources precipitated managerial improvements. No editorial, no probing inquiry and no reports affected the organization structure or influenced management techniques. The same team of Industry, Academic and Civil Service personnel performed this 100% success as that which participated in the *Ranger VI* so-called 100% failure. The uninformable and biased observer probably will have difficulty in coping with the implications and real meaning of that thought. The laurels should be placed where deserved, on the doers, but not on the critics; the latter dare not bask in this reflected glory.

Finally, since this is the usual contemporary mode, who should be investigated now? Also, who will prosecute the inquiry into success with equal diligence as the scalp hunters? Who should be named from among the array of vampires who hunt out embattled projects to sap the vitality and energies that would be better devoted to the burden of fixing, rather than fending off unwarranted blows? Why can't the vigilance be directed to the constructive? Surely this would be much more profitable than destructive attacks.

So I suggest that you should wish to lay aside your vendettas now that they have been proved to be misdirected. It would seem better for you to resume accurate and objective reporting as befits a responsible commentator for the industry. Join in the doubly deserved praise and congratulations for those who surmounted the dual obstacles of an exceedingly difficult mission and the unwarranted criticism.

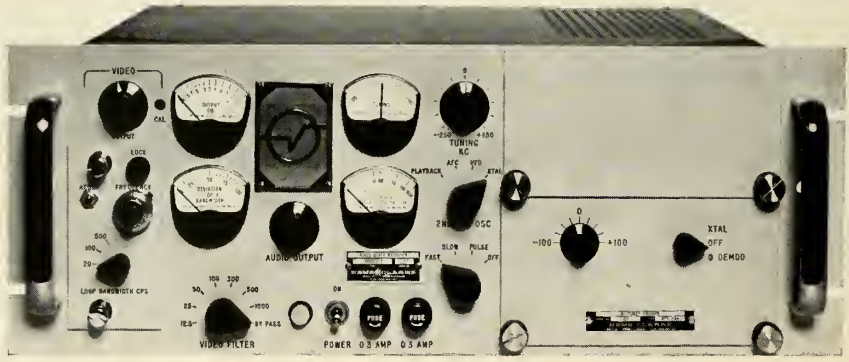
David E. Shaw
Glendale, Calif.

M/R is of course gratified by the success of Ranger VII, and so indicated editorially (Aug. 10, p. 54). However, we believe that the success was in part assured by the several investigations that followed the earlier failures.—Ed.

To the Editor:

Congratulations to JPL, hiss the villain W. J. Coughlin.

Stanley L. Brossman, Jr.
Student, E.E.
Milwaukee



This is the world's most advanced VHF/UHF receiver. In the recent NASA/JPL Ranger 7 moon probe it participated in such important commands as mid-course correction and antenna changeover. These receivers are in use at all deep space instrumentation facilities at Goldstone, California, Cape Kennedy, Florida, Johannesburg, South Africa, and Woomera, Australia. They are special modifications of the Nems-Clarke solid state type 1037A...by Vitro Electronics. Write for information.

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The Countdown

WASHINGTON

Space Plan To Remain under Wraps

Decision that NASA's report to President Johnson on advanced space planning will not be released publicly is a political one. Sen. Goldwater will be blocked from sniping at the program while President Johnson can make public use of those parts which he wants to publicize.

HIBEX Static Test Set for Fall

First static firing of the *HIBEX* (*HIgh-g Boost EXperiment*) is set for this fall at Allegany Ballistics Lab. If successful, this will be followed by shots at White Sands Missile Range. That's the schedule outlined by Dr. Robert L. Sproull, director of the Advanced Research Projects Agency. ARPA is spending some $16 million on the *HIBEX* program, being carried out by Boeing and Hercules. Success will lead to a more sophisticated program aimed at an interceptor missile beyond *Nike-X*.

NASA Space Station To Get $20 Million

NASA's growing interest in its own space station program is illustrated by the apportionment of its FY '65 manned space flight study funds. With well over $20 million allocated for the projects, officials report that more than 50% will be devoted to studies of future Earth-orbital missions. Three other areas—lunar exploration, planetary and launch vehicles—will share equally in the other funds.

No Funds for Radio Astronomy Satellite

There are clear indications that the *Radio Astronomy Explorer* satellite project will not receive any FY '65 funding. Top NASA officials recently ruled out a new start for the program. The decision now is being appealed by the Goddard Space Flight Center. A final decision is not expected until the agency completes its apportionment of FY '65 budget recently approved by Congress.

Scout Is Prepared

NASA scheduled the launch of the *Ionosphere A Explorer* satellite for Aug. 25. The launch was cancelled last March because of problems with the *Scout* booster. But the *Scout*, which has since chalked up two successful recent launches, will be used for the Aug. 25 shot at Pacific Missile Range.

Rome Using Echo Satellite

Rome Air Development Center's Passive Research Terminal at Floyd, N.Y., is using the NASA passive communications satellites—*Echo I* and *II*—for voice transmission tests. RADC has communicated with receiving facilities at Ohio State University and the Trinidad station in the Atlantic Missile Range tracking complex.

Polaris Rate Exceeds One per Month

Navy is turning out *Polaris* fleet ballistic missile submarines at a somewhat faster rate than the average one-per-month. Between now and March, 1965, twelve more submarines are expected to become operational, boosting the total submarine force to 28. This averages out to 1.5 in the eight-month period.

AF Wants Bigger Cap Pistol

A larger-thrust version of Cap Pistol—the tape with small solid-propellant charges affixed to it at intervals—is under development by the Air Force. The present version of the small attitude-control system, which has been highly successful, produces 1 lb. of thrust for ten milliseconds; the larger model would boost this output to 10 lbs. thrust for ten milliseconds.

INDUSTRY

Sylvania To Produce Sprint Components

Sylvania Electric Products, Inc., has won a $350,000 contract from Bell Telephone Labs to produce electronic components for the Army's high-acceleration *Sprint* missile. *Sprint* is being developed by the Martin Co.'s Orlando Division for the *Nike-X* anti-missile missile program.

IBM Picked for Computer Study

IBM has been selected on a sole-source basis for a one-year study of how the triple redundant computer in the *Saturn V* could be used as a backup computer for the *Apollo* spacecraft guidance and navigation system. Award calls for preliminary design and program definition.

Martin To Study Deep-Space Probe

The Martin Co. has received a $269,000 contract to study an advanced micrometeoroid deep-space satellite. The probe would be used to study meteoroid impacts near the Moon and would have an apogee of 172,000 mi. and a perigee of 460 mi.

Marshall Calls for More Bids

Fourth and fifth in a series of 10 RFP's for support services at the Marshall Space Flight Center have gone out to industry. Some 42 firms were invited to submit bids for support services at the Management Services Office with bids due Oct. 2. Fifty-one firms were asked to submit bids for the contract at the Technical Services Office. Bids are due on Oct. 1.

Connecticut Production of RL-10 Ends

Production of the RL-10 liquid hydrogen engine at the East Hartford, Conn., plant of Pratt & Whitney has ended. The firm will continue to turn out the engine at its West Palm Beach, Fla., facility. NASA says the cutback has been in the wind since reduction in the number of *Saturn I* flights planned. RL-10 powers the S-IV stage of *Saturn* as well as the *Centaur* upper stage.

INTERNATIONAL

Soviets Claim Anti-Polaris Development

The Russians have claimed development of a listening device which can pinpoint the location of U.S. *Polaris* missile submarines and guide ASW jet aircraft to the scene. The device is described as a small radio-hydro-acoustic buoy. The Soviets say the buoy will indicate the number and exact location of the subs. U.S. Navy sources regard the report as an exaggerated performance claim for a conventional sonobuoy.

START Contract Let

Martin Marietta Corp. has been awarded a contract for work on an advanced re-entry test program as part of an Air Force Space Technology And Re-entry Test (START) program.

The initial cost-plus-incentive-fee contract was for $2.75 million, with the eventual three-year cost expected to be $35 million. According to the Air Force, however, this is just one of 10-14 areas that have been identified in the START program—an acronym assigned by the Air Force to the expanded *ASSET* program.

The award of the contract to Martin does not mean that the company has an advantage over other aerospace companies in the eventual selection of a START development contractor. Nor does it mean that McDonnell, the original *ASSET* contractor and also a participant in START studies, has the inside track, Air Force officials stress. This is an expensive program and other contracts will be let in various areas, they say.

Details of the START program, which is being managed by Space Systems Division of the Air Force Systems Command, have not been made available. In June, however, an SSD planning officer told a group of reporters that the follow-on *ASSET* would have a lift-to-drag ratio of 1.2, versus 1.0 for the present *ASSET*, and will re-enter at speeds up to 25,000 fps.

The craft was also described as having a wingspan of about 4 ft. and a weight of 1,600 lbs. The expanded *ASSET* program and the *Manned Orbiting Laboratory* were begun after cancellation of the *Dyna-Soar* project in December, 1963.

Martin will perform work under the contract at its Space Systems Div. in Baltimore.

GAO Hits Leasing Practice

Three Defense Department contractors and DOD have been charged with costing the Government a total of almost $60 million over 10 years by leasing electronic data processing equipment rather than having the Government buy it.

The General Accounting Office made the same charges in all three cases—that the leasing cost the Government substantially more in the form of reimbursable costs and as elements of contract prices paid by the Government than it would have if the Government had purchased it and furnished it to the contractor for Government work.

GAO said that the contractors generally disagreed that unnecessary costs were incurred through the leasing practice. The GAO also said that DOD replied that while it agreed with the basic concept of acquiring and utilizing electronic data processing equipment in the most economical manner, it "expressed its intention to avoid furnishing data processing equipment to contractors as Government-furnished equipment unless the equipment is Government-owned and is an excess status."

Poodle May Get Nod from AEC

A multi-million-dollar advanced development program involving the TRW-Space Technology Laboratories' concept of a low-thrust radioisotope system—*Poodle*—may get the blessing of the AEC before the end of the month.

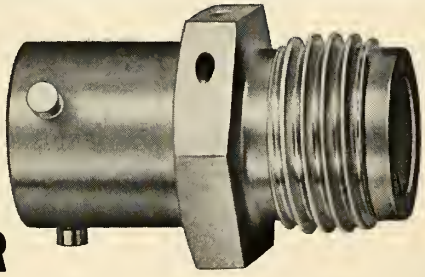
Interest in the concept runs up to White House level, and the program itself would be spread over a three-year period covering the development of flying hardware.

Poodle is the result of a $750,000 study conducted by TRW-STL under the joint sponsorship of the AEC and the Air Force's Aerospace Propulsion Office at Wright-Patterson AFB, Ohio (M/R, June 8, p. 22). Even though the Presidental Science Advisory Committee was reported to be "highly impressed" with the system following an AEC briefing, both NASA and the Air Force exhibit a reluctance to establish a requirement for the stage. STL estimates the development of a *Poodle* upper-stage would cost around $54 million.

Shots of the Week

NASA used the new *Thrust-Augmented Delta* to launch *Syncom III* from Cape Kennedy Aug. 19. The satellite passed its first test later in the day by receiving and returning the National Anthem to the tracking ship, Kingsport, based at Guam. (See story, p. 13.)

- Britain successfully launched its first stabilized *Skylark* rocket from the Woomera, Australia, range Aug. 13.
- The Soviet Union on Aug. 18 launched *Cosmos* satellites *38, 39* and *40*, all aboard the same vehicle. The vehicle is said to be of a new type.
- A crew from the Strategic Air Command's 359th Strategic Missile Squadron successfully launched a *Titan II* ICBM from Vandenberg AFB, Calif., Aug. 13. Purpose of the shot was to gain performance data on the system. Initial telemetry reports indicated that the missile was on course for its Pacific Missile Range target.
- NASA used a *Scout* to boost a



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reinforced plastic resin test sample to an altitude of 130 mi. Aug. 18 from Wallops Island, Va. The rocket's fourth stage was used to thrust the sample back through the atmosphere at 19,000 mph. Test was termed a "complete success."

• NASA test pilot Milton Thompson flew the *X-15* rocket plane Aug. 13 from Edwards AFB, Calif. Purpose of the 113th flight was to conduct airflow measurements, study the heat transfer rate and to continue study of boundary layer noise.

Titan III SCF Test Successful

The successful sequenced compatibility firing of the first two liquid stages of the *Titan III* launch vehicle at Martin-Denver paved the way to the first test launch of the vehicle at Cape Kennedy later this month.

All airborne systems were operated in sequence and in conjunction with ground equipment during the captive flight. All test objectives were met in the 40-sec. firing August 14. The actual vehicle involved was the *Titan III-A*, one of two configurations in which the booster will loft payloads ranging from 5,000 to 25,000 lbs. into orbit. The *Titan III-C* version includes the 2-million-lb.-thrust solid strap-on boosters.

Depressed Areas Aided

NASA and the Dept. of Defense have made major strides in aiding labor surplus and depressed areas through procurement practices during FY 1964, a Senate subcommittee was told.

Top level DOD witnesses told the Senate Small Business subcommittee chaired by Sen. Hubert Humphrey (D-Minn.) that a stepped-up program has resulted in increasing DOD procurement awards to labor surplus areas by $700 million in FY 1964, bringing the figure to $4.5 billion. At the same time, the number of labor surplus areas decreased from 44 to 39.

DOD officials also said that reports from major contractors indicated that from 15 to 20% of their subcontract dollars are flowing to labor surplus areas. This, they said, indicated that at least $6.5 billion of DOD procurements were placed with labor surplus area concerns in FY 1964.

Soviets Developing ASP

Soviet Chief Air Marshal Konstantin Vershinin, in an interview with the Soviet news agency Tass, said the USSR is developing an aerospace plane that "our generation" will see fly. Vershinin says that such a craft is "technically feasible," and that Soviet scientists and engineers are concentrating on development of the plane "not without success."

AF Names Scientists

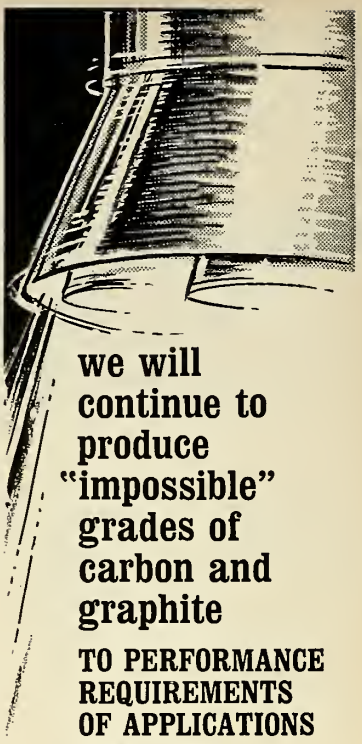
Dr. Winston R. Markey, assoc. professor at Massachusetts Institute of Technology's Department of Aeronautics and Astronautics, was named to succeed Dr. Robert W. Buckheim as Chief Scientist of the Air Force. Dr. Markey, 35, holds a doctorate in Instrumentation. He assumed his duties Aug. 17 for a period of one year.

Dr. Bernhard H. Goethert, vice president and chief scientist of ARO, Inc., was named chief scientist of the Air Force Systems Command replacing Arthur G. Wimer, Jr. Dr. Goethert holds a doctorate in aeronautical engineering from the Technical University of Berlin. Mr. Wimer will remain with AFSC as Asst. Deputy Chief of Staff for Science and Technology.



Boeing Gets M/R Award

DR. EDWARD C. WELSH, center, acting chairman and executive secretary of the National Aeronautics and Space Council, recently presented MISSILES AND ROCKETS' *New Product of Year award to Al Barstow, left, and William Marsh, Boeing Aero-Space Div. co-inventors of a microminiature welder.*



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Post-Apollo Report Due Sept 1

Rundown of future NASA program plans, ordered by President last spring, may not reach LBJ in its entirety until end of year

by Hal Taylor

THE REPORT on NASA's post-*Apollo* program plans requested by President Johnson last spring (M/R, May 4, p. 12), will be in the hands of Administrator James E. Webb by Sept. 1, but some of it may not reach the White House until the end of the year.

A member of the task group preparing the report said that it would be in Webb's hands by the Sept. 1 deadline set by the White House.

Dr. Edward C. Welsh, acting chairman of the White House's Aeronautics and Space Council, said he did not expect that some portions of the document would be received by the White House until the end of the year. He also said it probably would not be released publicly.

Welsh said the report will be composed of both verbal briefings and written material. As a result, it may be received in bits and pieces, which could drag out the process until later in the year.

It is also expected that the report will be coordinated by NASA with other agencies such as the White House's Scientific Advisory Board and the Dept. of Defense. The space agency sent a preliminary summary of the report to White House officials on May 26.

White House officials denied that the report would be used as the basis for some important new Presidential declaration of new goals for the U.S. space program. They said similar reports are required annually from other government agencies. They did not, however, dispute the possibility that during the campaign the President might make a speech or statement on the space program—which of course is part of the Kennedy-Johnson Administration record.

Persons close to the report say that it is unlikely that the space agency will state target dates for future programs. They expect that it will, instead, emphasize the required research and development which will have to be done in order to carry out future programs which the agency would like to undertake.

● **Known interests**—While nothing has been said officially, the early-priority programs favored by NASA have already been discussed publicly by space agency officials. These include the *Extended Apollo* spacecraft and the LEM truck spacecraft for extended exploration of the lunar surface.

Officials already have indicated that they expect to go to the program-definition stage on those projects with FY '66 funds. Some development of critical-long-leadtime subsystems is also expected to be initiated.

The other likely candidate for FY '66 funds is the *Voyager* unmanned interplanetary spacecraft series. Some space agency officials report that if such a spacecraft is to be launched toward Mars by 1971, a decision will have to be reached by Jan. 1, 1965. They are currently optimistic that hardware money will be in the next fiscal year's budget. ■

NASA Finalizes Mission Schedule for Entire Gemini Program

MANNED SPACECRAFT CENTER has definitized the schedule for the two-man *Gemini* manned spaceflight program which calls for six separate rendezvous missions lasting two days each.

The schedule—finalized only recently—details the mission and duration for the 11 flights still remaining in the program. *GT-1*, an unmanned orbital flight on April 8, 1964, was a success.

The rendezvous flights include two tests of rendezvous methods—concentric and tangential trajectory. The other four flights will practice four possible rendezvous missions. Same-day rendezvous calls for the B *Gemini* spacecraft and target vehicle to be launched on the same day and with the rendezvous taking place when the *Agena* reaches its fourth apogee. Direct-ascent rendezvous will have the hookup in space as the *Agena* reaches its first apogee. The other two rendezvous flights test techniques which may be used during manned *Apollo* flights to the Moon.

MISSION NO.	DURATION	MISSION
GT–1	64 Orbits	Unmanned—Launch Environment
GT–2	Ballistic	Unmanned—Systems Qualification
GT–3	3 Orbits	First Manned Flight
GT–4	4 Days	Long-Duration
GT–5	7 Days	Long-Duration
GTA–6*	2 Days	Mode II Rendezvous Development
*(Gemini-Titan-Agena)		(Concentric Trajectory)
GT–7	Up to 14 Days	Long-Duration (No Agena)
GTA–8	2 Days	Mode I Rendezvous Development (Tangential Trajectory)
GTA–9	2 Days	Same-Day Rendezvous
GTA–10	2 Days	Direct-Ascent Rendezvous
GTA–11	2 Days	LEM Rendezvous Simulation
GTA–12	2 Days	LEM Abort Simulation

Launch phase 'perfect' . . .

Syncom III May Allow First TV Experiments From Stationary Orbit



THRUST-AUGMENTED DELTA lifts off bearing Syncom III satellite.



TECHNICIAN checks Syncom III before its launch from Cape Kennedy.

THE FIRST television experiment with a satellite in truly stationary orbit will be attempted this week if the *Syncom III* satellite reaches its planned position over the intersection of the international dateline and the Equator.

All systems were apparently working successfully on the satellite as space agency officials prepared to fire its apogee kick motor Aug. 20 at about 12:45 pm EDT.

Syncom III was launched from Cape Kennedy at 8:15 a.m. EDT Aug. 19 in the first flight test of the *Thrust-Augmented Delta* booster.

Preliminary data indicated that the satellite had reached a "nominal" orbit with an apogee of 23,675 miles and a perigee of 695 miles. Its period was 11 hours and 35 minutes.

● **Last of series**—The satellite will probably end the *Syncom* series. Space agency officials said that they will consider a fourth satellite in the series only if the *Syncom III* fails to function as intended.

The first communications experiment was begun at 11:59 a.m. Aug. 19. The voice communication was transmitted from the USS Kingsport at Apra, Guam, to the satellite and then back to the ship. The first test of one satellite aiding another in data transmission was then performed successfully when range and range rate data was received from *Syncom III* via its orbiting sister satellite, *Syncom II*.

The data was sent to a portable station at Clark AFB in the Philippines from where it was sent via cable to the U.S. West Coast terminal point at Oakland, Calif., and then via land line to the Goddard Space Flight Center, Greenbelt, Md.

● **Apogee kick**—The apogee kick motor is designed to move the satellite out of its looping eliptical orbit and put it into circular synchronous orbit. It is designed to be in alignment at that time with the Equator if the maneuver is successful.

Any drift of the satellite toward the west or east at a slower than planned speed can be corrected by firing a hydrogen peroxide gas jet. After about 10 days—Aug. 29-30—another gas jet will be fired to stop the drift and hold the satellite on station.

At this point the satellite will appear to remain over one spot on the Earth. In reality it will be keeping pace with the Earth's rotation by travelling at about 6,800 mph at its 22,300-mile altitude in order to match the Earth's Equatorial speed of 1,040 miles.

If the satellite reaches its planned position in good working order, it will be used to transfer live TV pictures of the Tokyo Olympic games during the Oct. 10-24 period. There will be no voice transmission.

● **Launch termed perfect**—The first launch of *TAD* was perfect. Its solid strap-on motors burned for the allotted 27 seconds and were jettisoned on time, 70 seconds after liftoff.

It was the third straight successful launch in the *Syncom* program. *Syncom I* was placed in orbit Feb. 14, 1963, but communication with it was lost shortly after its apogee kick motor was fired. *Syncom II*, launched July 26, 1963, is still operating.

Syncom, built by Hughes Aircraft Co. for NASA, is constructed in two units. An outer structure supports the solar panels and contains the hydrogen peroxide tanks and axial and radial jets of the control system, and most of the electronics. An inner structure supports the apogee motor and the remaining electronics.

Antennas include a slotted array antenna for communications transmission, a slotted dipole for communications receiving and four whip antennas in a turnstile arrangement for telemetry and command.

Syncom has a passive temperature control system. That is, adequate temperature control is achieved by the design and materials used on the external surface and by properly insulating subsystem equipment. ■

McNamara Claims Big Strategic Edge

DEVELOPMENT of the greatest military power in history—with a capability to respond to every level of aggression—is beyond question the most significant achievement in the defense establishment during the present Administration, Secretary of Defense Robert S. McNamara told the Democratic platform committee.

In a wide-ranging, highly political survey of his stewardship, the Defense Secretary last week viewed with alarm the nation's defense posture when the Democrats took office in 1961 and pointed with pride to the changes that had been wrought in the short space of three and one-half years.

"The defense establishment we found in 1961," he lamented, "was based on a strategy of massive nuclear retaliation as the answer to all military and political aggression. We, however, were convinced that our enemies would never find credible a strategy which even the American people did not believe."

The Secretary also found the 1961 defense establishment deficient in:

—*Planning:* Each military service did its own planning. The Army was stockpiling for a war which would last several years while the Air Force prepared for a war of several days.

—*Budgeting:* Military strategy was a stepchild of a predetermined budget, with funds being allocated not on the basis of military requirements but according to the dictates of an arbitrary fiscal policy.

—*Strategic forces:* Vulnerable to surprise missile attack.

—*Non-nuclear forces:* Weak in combat-ready divisions, weak in airlift capability and weak in tactical air support.

—*Counter-insurgency forces:* For all practical purposes non-existent.

● **Not a moment too soon**—By investing $30 billion more for the fiscal years 1962-1965 than would have been spent at the level of the last defense budget of the previous Administration, the former Ford president told the platform committee, the U.S. has vastly increased its strategic nuclear and its conventional strength. Among the increases cited were 150% in the number of nuclear warheads and 200% in total megatonnage in the strategic alert forces.

Increases were also noted in the tactical nuclear forces in Western Europe (60%), the number of combat-ready divisions (45%) the number of tactical fighter squadrons (44%), ship construction (100%) and counter-insurgency forces (800%).

Contrasting U.S. strategic strength with that of the Soviet Union, McNamara termed U.S. strategic capability "incontestable." (See chart.)

"Let me assure you," he told the committee, "that our strategic forces are and will remain in the 1960's and the '70's, sufficient to insure the destruction of both the Soviet Union and Communist China under the worst imaginable circumstances accompanying the outbreak of war. There should be no doubt of this in the mind of any American. There is none in the minds of our enemies."

Developing the theme of President Johnson that the United States "is, and will remain, first in the use of science and technology for the protection of its people," McNamara pointed to a 50% increase in expenditures for military research and development "over the level prevailing during the last four years of the previous Administration." A charge has been made that R&D expenditures during the past three years have increased only 10-15% which "barely" covers increased costs.

Among the fruits of this labor are the *Polaris A-3,* which became operational this month, and the *Minuteman II.* Of the latter, McNamara said that it is "as great an improvement of the *Minuteman I* as the B-52 was over the B-47. It will be more than eight times as effective against the best-protected military targets as its predecessor."

New projects "initiated or carried to completion during this administration", according to Secretary McNamara include: the SR-71 strategic reconnaissance aircraft, the *Nike-X* anti-missile missile system, the A-7A attack aircraft for the Navy, the EX-10 torpedo, the Main Battle Tank and the F-111 fighter-bomber. All of these systems are under development and, therefore, presumably fall in the "initiated" category. In addition, 208 weapons research projects, including 77 costing $10 million or more each, have been initiated. ■

McNAMARA'S REPORT—

U.S. vs. USSR Strategic Forces

BOMBERS:

U.S. has 1,100, including 550 on 15-min. alert, equipped with decoy missiles and other penetration aids.

USSR, with difficulty, could place over this country on two-way missions slightly more than 100 heavy bombers, plus 150 medium bombers capable of striking only Canada and the northwestern corner of the U.S.

U.S. has 4 to 1 superiority

INTERCONTINENTAL BALLISTIC MISSILES:

U.S. has more than 800 fully armed, dependable ICBM's deployed on launchers, almost all in hardened and dispersed silos. USSR has fewer than 200 ICBM's, and fewer still in hardened silos.

U.S. has 4 to 1 superiority

SUB-LAUNCHED BALLISTIC MISSILES

U.S. has 256 *Polaris* missiles deployed in 16 submarines; 25 more *Polaris* submarines are under construction; all are carried in nuclear-powered submarines; all can be launched from beneath the surface; each *Polaris* missile has range of 1,500 mi. or more.

USSR has 142 missiles which, by comparison with *Polaris,* is a small and ineffective force; only a small percentage of Soviet ballistic missile submarines have nuclear power; Soviets have no operational missile that can be fired from beneath the surface; range of Soviet submarine-launched missiles is under 500 mi.

U.S. superiority both quantitative and qualitative

ABL Mars Landing May Come in 1971

Officials note cost, sterilization problem; NASA tells details of Mariner Mars flybys scheduled for this fall

A NASA OFFICIAL indicates it probably will be 1971 or 1973 before the U.S. lands a large integrated *Automated Biological Laboratory* (*ABL*) on Mars.

Dr. Orr E. Reynolds, director of NASA's Office of Bio-sciences, told MISSILES AND ROCKETS, "I think it would be awfully optimistic to think that we could fly a fully integrated laboratory system to the Martian surface in 1969."

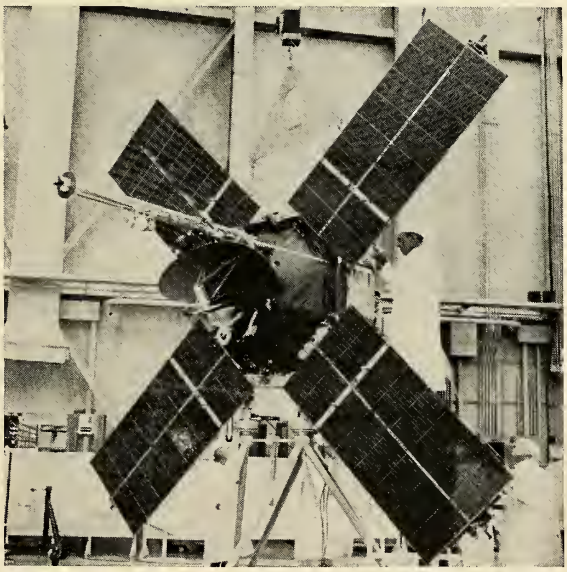
"I would like to hope such a mission would be feasible in 1971, and the 1973 launch window would also provide a good opportunity," he said.

As for 1969, Reynolds said he hoped that during that year the space agency could mount a good Mars orbiter mission.

Other NASA officials, however, viewed the launch of a large *ABL* with the *Saturn V* booster in 1971 as improbable. They noted its high cost as well as what one of them termed "problems with sterilization methods which have to be solved."

All sources agreed, however, that any *ABL* mission will be part of the *Advanced Voyager* program and will not constitute a separate program entity. As far as the space agency is concerned, *Voyager* will not be simply the name of a spacecraft, but rather the title of a program which envisions many missions to Mars as well as other planets.

● **Big plans for Mariner**—The comments on the *ABL* program were learned as NASA released details of two upcoming flybys of Mars with the *Mariner* spacecraft. The two flights, scheduled for this fall, will be the most difficult unmanned space flights ever attempted by this nation.



ONE OF TWO Mariner Mars spacecraft, scheduled for launch this fall, is shown being prepared by technicians at Jet Propulsion Laboratory in Pasadena, Calif., for shipment to Cape Kennedy. Spacecraft's four solar panels are extended from octagonal base. Elliptical dish is high-gain antenna. Tube-like device above dish antenna supports Mariner's low-gain antenna, wave guide and instrumentation for two scientific experiments—magnetometer sensor and ion chamber.

The two vehicles will have to travel some 350 million miles and operate for at least nine months if the first TV pictures of the red planet are to be sent back to Earth.

The launch window for the two shots is late October-November. In addition to the television shots, the spacecraft are also designed to report on the radiation, magnetic fields and micrometeorites in interplanetary space.

Apart from the long duration of the mission, the two *Mariner* flights will also mark:

—Transmission of high-frequency radio signals over long distances. The communication distance from Mars is more than 150 million miles, compared with only 53.9 million miles achieved for the 1962 *Mariner II* Venus flyby mission.

—First use in space of a mid-course guidance rocket which will have the capability of being fired twice.

—First use by NASA of the *Agena D* second stage and an improved version of the *Atlas D* booster.

—First use of the star Canopus for spacecraft attitude control.

The two spacecraft will weigh about 570 lbs. They will have a wingspan of 22 ft. with their solar panels extended and a height of 9½ ft. Flight times will vary from 7½ to 8½ months, depending on the day of launch, with the additional three weeks of flight beyond the planet needed to return data.

It is expected that the proximity of Mars to the asteroid belt may produce a higher incidence of micrometeorites than was the case in the flight of *Mariner II* from Earth to Venus in 1962. Part of the exploratory nature of the first Mars mission will be to determine if micrometeorites constitute a serious hazard in flights to Mars.

The first Mars mission also will yield important data on space navigation over great distances and on the capability of powering a spacecraft by converting sunlight to electricity during a mission in which the Sun-spacecraft distance is steadily increasing. The Mars *Mariners* will be equipped with four solar panels, compared with two for *Mariner II* and the *Ranger* lunar impact spacecraft. ■

Sea Hawk System May Appear Gradually

by James Trainor

SEA HAWK—The Navy's advanced design anti-submarine destroyer escort system—is undergoing a close and critical appraisal by Vice Adm. Charles B. Martell, the Navy's ASW director. This promises to change radically the original concept of the integrated ASW weapons system.

Rather than taking the complete form of a ship designed from the keel up, and optimized for the ASW mission, it now appears that the Sea Hawk system will appear gradually in pieces —some subsystems being accelerated to expedite their early introduction into the fleet while others are still in advanced development. Development of the integrated ASW ship will wait until these components are further advanced.

The first component of the Sea Hawk system likely to be introduced into the next class of destroyer escorts is a new gas-turbine powerplant. This development is already far advanced and can be available in the immediate future, Defense officials stress.

The two major subsystems which have significantly longer leadtimes are the high-resolution radar and the sonar array. The first is expected to be an advanced-design array radar with ability to scan wide ocean areas—so that "if a sub shows itself at all, it is dead"—and also to check on sonar contacts. The sonar is also an advanced development, and will take advantage of "new techniques and different shapes," including planar and cylindrical array designs. Although some preliminary effort has been funded in both of these areas, neither has yet gone through a project definition phase.

● **Original concept**—When the Sea Hawk concept was first enunciated a little over two years ago, and finally defined as a specific operational requirement in January, 1963, it was to have been a ship of about 3,500 to 4,500 tons. This limitation on size was intended to reverse the post-World War II trend to larger and larger destroyer-class ships. At the same time, the numbers and skills of personnel manning Sea Hawk were to be reduced. Reliability, maintainability and cost/effectiveness were major considerations in the Sea Hawk shipbuilding program. A quick-reaction ship-to-underwater missile with a longer range than *Asroc* was also included in the plan.

Two further requirements, and the ones which made this ship unique, were a very high-speed search rate with a sonar cruise speed of better than half the ship's top speed, and the integrated design of a special-purpose ship for the ASW mission. Although optimized for the anti-submarine mission, Sea Hawk was not to be limited to a single mission but, like all Navy ships, was to be able to perform, to a limited degree, anti-air and amphibious support roles.

A test ship with some of the critical components was to have been included in the Fiscal 1966 shipbuilding program. Under this program, Sea Hawk was expected to provide a new ASW escort in time for the Fiscal 1969 building program.

● **What happened**—On arrival of Martell as "Mr. ASW" for the Navy in June of this year, his office (Op-95) undertook a review of all ASW programs. Sea Hawk was singled out for special review.

It was found as a result of this detailed examination of the program that the Sea Hawk plan contained idcas, proposals and hardware in various stages of development. The first step then was to sort out these components and categorize them—since the Navy was unwilling and unable to go into development without more data, according to a DOD official. As a result he expects to see accelcration of certain parts of the program, such as the gas turbine propulsion system, while others, the radar and sonar, are placed in different categories.

"It doesn't make sense to save everything until all the systems of Sea Hawk are at the same stage of development," a Defense official points out, "when we can improve our capability right now by introducing elements that are ready."

It is just this approach to the Sea Hawk program which disturbs industry. "It means that we are back to the piecemeal approach to the ASW problem," is the way one company official puts it.

Recent studies of Navy force levels have also had a profound effect on development of the integrated ASW ship. Examination of forces in being, and those under construction or authorized for construction, has purportedly proven that the need for an early introduction of a Sea Hawk-type ship is not as great as once thought.

Finally, money played an important role in the program's re-appraisal. "We have to accept the fact that we need more money in ASW," a DOD official told MISSILES AND ROCKETS, "and, until we do, some things may have to be deferred for higher-priority items."

● **Resolve not weakened?**—Although industry is already complaining of "incremental improvements," Navy and DOD officials stress that there is no weakening of the intention to approach at least the electronics, from sensor to fire control, as an integrated system.

Martell himself terms the Sea Hawk a "program of very great significance" in which the Navy is looking for a quantum jump in capability. The prime requirement for such a system is a high search rate, he points out. The appraisal of Sea Hawk by Op-95, therefore, is to emphasize those areas essential to a quantum jump in capability. However, neither he nor DOD talks of a single integrated ASW DE as the answer. ■

Maxson Takes 2nd Sole-Source Award—for Drones

MAXSON Electronics Corp. has won a sole-source production contract for the AQM-37A target drone, developed by Beech Aircraft Corp.

The award, by Navy's BuWeps, is the second of its kind to go to Maxson within recent weeks. In June, BuWeps awarded the firm a sole-source contract to produce the Martin Co.-developed *Bullpup* air-to-surface missile.

In the drone contest, Maxson won out over seven other bidders —Beech, Aeronca, Emtex, Kaman, Northrop, Raytheon and Sperry Farragut. First-year increment of the fixed-price five-year contract is worth $3,751,044. Eventual value is $13,189,223.

NASA Assessing GT-2 Damage at Cape

Titan's electronics, GSE appear damaged; if seriously harmed, could mean vehicle substitution; some slippage certain for GT-2 and GT-3

FULL EXTENT of damage done by lightning on Aug 17 to the *Titan II* launch vehicle for *GT-2* will not be known until sometime this week. Some damage was apparently caused to the vehicle's electronic systems and to its ground support equipment.

If damage proves slight, the accident will cause only short delay in the GT-2 launch date.

Extensive damage, however, could necessitate a switch to the third *Gemini-Titan* vehicle currently undergoing vertical test at Martin's Baltimore plant in preparation for its planned use in *GT-3,* the first manned *Gemini* flight.

Service buildings in Cape Kennedy's Pad 19, where the *GT-2* booster was on the test stand, are protected by lightning arrestors. It is reasoned, however, that with some 800 miles of cable in the complex, a lightning strike anywhere in the area could have been transmitted through the cables into the blockhouse and the launch vehicle.

● **GSE check first**—The booster's ground support equipment will undergo initial checkout. If the GSE is not severely damaged, it will then be used to check out the rocket.

Engineers will also perform an on-paper analysis to determine what systems in the vehicle might have been affected by lightning hitting any part of the associated wiring.

Lightning has never hit a rocket at the Cape before, and this fact reinforces the theory that the damaging current arrived through cabling, rather than by a direct hit on either the vehicle or the service tower.

A large amount of preflight testing had been completed on the booster before the accident. The *Gemini* capsule is still not ready for mating to the booster, however.

GT-2 had been scheduled for flight during the first week of October. At best, it will now be delayed several days. The *GT-3* manned mission had been scheduled to go before Christmas. It will now almost certainly slip into early next year.

The second *Gemini* shot will be an 1,850-n.mi ballistic flight reaching an altitude of 87 n.mi. and is intended to qualify the craft's subsystems.

Altogether, the *Gemini* program calls for 12 missions, 10 of them manned and six rendezvous flights. ■

AF Conducting Lightning Tests



LIGHTNING MACHINE model demonstrates how full-scale machine will be used in Air Force Weapons Lab tests.

KIRTLAND AFB, N.M.—The possibility of a lightning strike crippling one of its ICBM's on the launch pad has led the Air Force to set up a series of simulated lightning tests at the Air Force Weapons Laboratory here.

Kirtland scientists last month took delivery on a transportable lightning machine built for them by Lightning and Transients Research Institute of Miami under terms of a $416,432 contract. The machine, essentially a giant capacitor capable of producing 50-ft.-long bolts with a potential of 10,000,000 volts and current of 100,000 amperes, will be used to conduct tests on salvaged *Jupiter* missiles.

The lightning machine, using the same concept as the Army Signal Corps' Marx surge generator, is mounted on a 5-ton trailer truck transporter similar to those used with the *Minuteman.* The transporter will erect the machine to a vertical position alongside a combat-configured *Jupiter.*

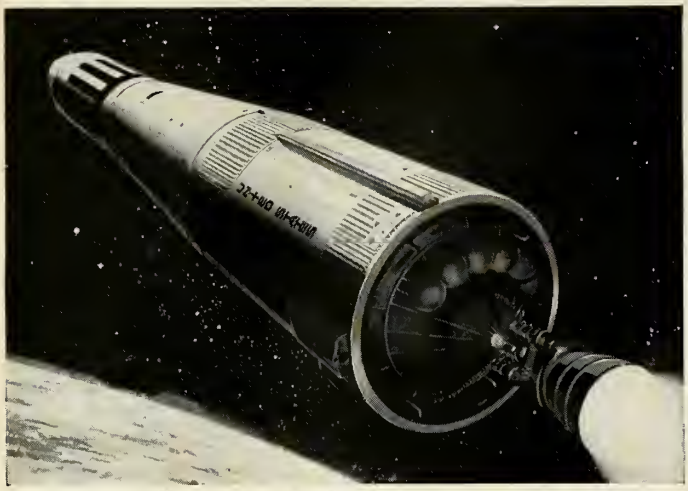
Electrical lines will feed the machine from commercial power sources or generators. Its banks of capacitors will accept the charge in parallel. When the capacitors are fully charged, the load will be instantly discharged in series through a system of spark gaps designed to create the lightning effect.

Several results from such a jolt are thought possible. Guidance circuits might be shorted, physical damage might be suffered by the missile frame, or self-destruction might be triggered. Should the bolt hit the command module or connecting electrical linkage, it could leave the missile without launch control. Also thought possible is ignition of the missile's fuel load.

Any of these occurrences could render the missile useless as a retaliatory weapon, and could make its destruction necessary.

The machine has been successfully checked out and accepted by the Air Force. Its next discharge is expected the first or second week of September and will use a *Jupiter* for a target. Initial test will be conducted on unfueled missiles. ■

If it's outer space, call on DOUGLAS!



TO HELP PUT MAN ON THE MOON, WE'RE BUILDING BOTH THE S-IV AND S-IVB stages of the Saturn moon rockets. The huge NASA/Douglas S-IVB (58 feet tall and 22 feet in diameter) will be responsible for injecting the Apollo manned spacecraft into earth orbit for extensive testing. Later it will become the third stage of Saturn V . . . go into orbit with the manned Apollo on its nose . . . restart its engine in space and send the U.S. astronauts on their way to the moon.



WE BUILD THE WORLD'S MOST RELIABLE SPACE BOOSTER . . . Delta, developed by Douglas under the direction of the U.S. National Aeronautics and Space Administration (NASA). Delta has performed perfectly in 22 successive space exploration orbitings including Telstar, Tiros, Syncom, Relay and Ariel.



WE'VE OPENED A NEW SPACE SYSTEMS CENTER which is one of the world's finest privately owned facilities for the researching, developing, building and testing of space vehicles. This new Douglas Center is designed to advance the technical leadership of the Free World in the great space programs of today and tomorrow.

DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION

Technical Countdown

PROPULSION

Maraging Steel Case Hits 375,000 psi

Air Force Propulsion Laboratory at Edwards AFB, Calif. reports a "significant advance in fabrication of high-strength, lightweight cases for solid propellant rockets" in a maraging steel developed under contract by Curtiss-Wright Corp. The Air Force announcement disclosed that last March, a solid rocket case made of 18% nickel maraging steel was "hydro-burst successfully at a pressure of 1,076 psi." The 40-in.-dia. x 78-in.-long case was 25% lighter than a conventional steel case of similar dimensions, and can he constructed in production quantities at approximately half the cost of some exotic lightweight metal cases currently used in Air Force missiles. Upon completion of the contract (it calls for production of three rocket motor cases), the Air Force says, "sufficient technical data will have been generated to allow the possible application of this technological advancement to future high performance solid rocket systems."

300-Gal. Mixer Installed at LPC Potrero

A million-dollar addition program to Lockheed Propulsion Co.'s Potrero, Calif., production and test facility is underway with the installation of a 300-gal. Baker-Perkins mixer. The addition also includes a large solid-motor cast-and-cure station—enabling the facility to maintain a production rate of four 156-in. motor segments per month. The installation doubles the current 60,000 lbs./day production rate. Sections of the second 156-in. motor are already arriving fully loaded at the test site from the firm's Redlands, Calif., facility for a firing scheduled this fall.

High Impact Recovery Perfected

Aerojet-General Corp.'s liquid rocket operations in Sacramento, Calif., reports development of a technique that permits the recovery of large boosters at an impact speed 10 times greater than had formerly been considered possible. The higher impact velocity permits an approximate 100-fold reduction in the size parachute that would be required. It also eliminates any need for touchdown retrorockets. R. C. Truax, director of advanced development for the liquid rocket operations, says the technique has been proved with models and that the company has modified a *Corporal* missile for a full-scale demonstration of the technique. Key to the recovery technique is design of the vehicle for water re-entry.

ADVANCED MATERIALS

Eddy Current Innovation Tests Fiber Orientation

Grain orientation in the graphite components of the *Polaris* first stage motor nozzles are being determined by Aerojet-General specialists using a special probe evolved from a commercial eddy current test device. The instrument is constructed to provide a unidirectional magnetic field so that directional conductivity in materials can he detected and measured. It is used to detect the orientation of materials having different electrical properties parallel and transverse to the filaments. Grain orientation and angle lay-up is directly related to uneven or excessive erosion. The technique is also applicable to detecting flow lines in forgings, effects of cold working and certain types of fatigue effects.

Sapphire Fiber Paper Felted

Single crystal sapphire fibers have been felted into paper form by Thermokinetic Fibers Inc., Nutley, N.J. The whisker paper contains sapphire fibers of 99.5% purity in diameters of about one micron and ⅛-in. lengths. The firm expects to produce the paper in 8-in. square mats of 0.010-0.020-in. thickness and eventually in continuous strips. Typical applications include composites requiring biaxial strength, ablative structures, plastic laminates and wafer-thin ceramic laminates.

Kaiser To Develop MgO for Wind Tunnels

A specialized magnesium oxide material able to withstand temperatures up to 4,000°F will he developed by Kaiser Refractories, division of Kaiser Aluminum & Chemical Corp. The material will be used as a heat exchange medium in connection with a research program on hypersonic aircraft at NASA's Ames Research Center. The contract with Ames calls for the production of initial quantities of various geometries with optimum physical properties. The refractories will be used in storage heaters that supply air at 4,000°F for hypersonic wind tunnel operations.

AMF To Build Solar Spectrometer

A device designed to detect and analyze solar X-ray radiation will be built for installation ahoard the fifth *Orbiting Solar Observatory* hy the Alexandria, Va. division of American Machine and Foundry Co.'s Advanced Products Group. The $511,000 NASA contract will be a second-generation device developed by AMF for the *OSO* program. The solar spectrometer will provide data on the physical condition and composition of the solar atmosphere.

SPACE MEDICINE

Dummy Irradiated in Studies

Lockheed-California spacecraft engineers have devised a plastic mannequin to study radiation penetration into the human hody. The lifesize dummy can be filled with a fluid chemically approximating the hlood and tissue of a human. and suhjected to doses of radiation to determine their effect. Nuclear laboratories in the Lockheed-Georgia Co.'s Dawsonville facility are being used. Data will contrihute to space station shielding design.

Study of Birth in Weightlessness Planned

NASA is funding a joint Air Force-University of Southern California project to demonstrate how several mice could be used to study the effects of weightlessness from six months to a year. The group is considering using a female mouse impregnated just before launch to see how weightlessness affects the birth and growth of the mammalian structure. While there are no flight plans, the project will develop prototype hardware for later consideration.

NASA Considering Litton-Developed 'Hard-Shell' Suit for Explorations

Second-phase suit, to be delivered in October, will provide greater mobility, faster donning time, use of two-gas system

by Heather M. David

A HARD-SHELL spacesuit that is reported to offer several advantages over the "soft" suits used in *Mercury, Gemini* and *Apollo* is being evaluated by NASA's Manned Spacecraft Center.

The suit was designed and engineered by Litton Industries Space Sciences Laboratory, in Beverly Hills, Calif. Contracts have been awarded by the office of Biotechnology and Human Research in the space agency's Office of Advanced Research and Technology.

Although the suit is not designed for a specific mission, it has obvious design features for lunar exploration and—with proper modifications—perhaps even planetary exploration.

Space Sciences Laboratory director Emil de Graeve says Litton will deliver in October a second-phase suit—the first-phase version with new improvements. The "RX-2" offers these advantages over soft suits:

—*Greater mobility*—Most important feature of the hard suit is that pressure is maintained throughout the suit at a constant volume. This is accomplished by constant-volume joints, a bellowed-type configuration patented by Litton. NASA's Dr. John Fuscoe reports that the degree of mobility in the suit eliminates any problem of the man becoming helpless if he should fall on his back. This mobility is incorporated down into the fingers, and a hard-suited subject has even found it possible to thread a needle.

—*Faster donning time*—Although this was not a requirement in the contract, donning time has worked out to be 90 seconds unassisted, and in weightlessness it is expected this will be reduced to 30 seconds. Soft suits, with flexible zippers, are expected to take more time.

—*Low weight*—Even in early developmental stages, the weight of the suit is competitive with soft suits, at about 72 lbs. Litton expects that more advanced versions will about halve this weight.

—*Universal fitting*—The suit designed by Litton will fit from the 50th to the 90th percentile, and in addition incorporates devices that can modify length of torso, arms and legs. Fuscoe says NASA envisions a final version as being available in three sizes to fit all candidates.

—*Two-gas system*—The controversial problem of alleged necessity for two-gas environments such as that on Earth would be considerably simplified by the use of this suit. Since the suit can accommodate pressures from 7 to even 15 psi, a two-gas system could be used. The danger of bends would be eliminated as the astronaut went from cabin to suit environmental control systems. Soft suits are designed for only 5-psi operation, and consequently demand pure oxygen.

—*Meteoroid and fire protection*—Although safeguards against meteoroids were not specifically incorporated into design of the surface of the suit, it is expected to offer improvement over soft suits. However, one area in which it will excel, De Graeve told MISSILES AND ROCKETS, is that the danger of flash burns will be greatly reduced with use of a two-gas atmosphere. If a meteorite should hit a suit with 100% oxygen and make a tiny puncture, he pointed out, the astronaut could be badly burned within the suit. The use of nitrogen would eliminate this fire hazard.

—*Comfort*—When pressurized, the suit will have no pressure points on the astronaut's body.

● **Description**—The suit is a two-piece, aluminum enclosure. The main difference between the first and second versions Litton has designed for NASA is that in the first instance the hip joint was made of cloth, while the rest of the torso was metal. This joint is considered the most difficult to design with the constant volume principle.

Shoulder, elbow and knee joints are described as "rolling convolutes," and are fashioned in a combination of fabric and metal. The ankle joint is a cardonic section allowing movement on two axes.

Instead of a zipper, the suit is fastened by a "doglock," such as that used in submarine hatches. This seal, although not ultimate, has fail-safe properties. De Graeve added that leakage is about 52 standard cc's per minute, which is an improvement by a factor of four over NASA's requirement of 200 cc's. In addition, he said, this leak rate holds after repeated donning and doffing.

The most familiar-looking part of the suit is the shoes, which are patterned after the Dutch sabot. De Graeve said



LEFT: Model in spacesuit demonstrates high degree of digital flexibility provided in Litton design.

RIGHT: Side-on view shows umbilical connections. In operation, umbilical lines supplying oxygen and nitrogen would be replaced by a backpack.



that Litton engineers thought of the sabot after discussing the requirements, bought a pair of Dutch wooden shoes for $4.90.

Finding that these shoes had just the amount of insulation they had deemed necessary for walking on the lunar surface, they were able to use the shoes as the actual mold. Only the point was shaved off, and some insulation (polyurethane) was pumped into the sole.

De Graeve pointed out that the wooden-shoe shape was an actual technological development made by the Dutch. It is the exact shape and design to get the most traction on a slippery surface such as mud. The same traction may be needed on the Moon, he said, if the surface is dusty or crunchy.

If the surface is so dusty that "snowshoes" may be needed, de Graeve said, they could be attached to the suit as it now is. However, he said, not enough is known now to warrant going into development of such an item at this time.

● **Proposed use**—The suit as now conceived is not considered applicable to early *Apollo* missions. Since it is rigid, it would, when not in use, take up as much room in the space cabin as the man himself. Also, some features of the breadth of the shoulder design are said to be incompatible with the *Apollo* design.

However, Litton expects to go into an accelerated program for development of an operational prototype extravehicular and lunar surface suit, aimed at post-*Apollo* mission requirements.

This next phase, which would produce RX-3, would use the *Apollo* thermal control system as government-furnished equipment and incorporate that into the suit.

De Graeve says Litton will also look more deeply into impact protection features, including means of cushioning the man in the suit with such devices as air bladders.

Litton will also look further into optimum design of the helmet, which at present is of one piece with the top of the suit. The possibility of putting in a rotating unit will be considered, although De Graeve said he is not convinced that it will be necessary.

Some attention will also be paid to requirements of biomedical monitoring.

● **History of development**—Litton actually began work on high-vacuum suits in 1954, under the direction of Siegfried Hansen. His objective was to design a protective garment which would allow his engineers to go into a high-vacuum chamber to work on equipment being tested or experiments conducted in the chamber. By 1956, he had success with the constant volume joint, which is key to the mobility of the suit.

Hansen was given support by the Air Force Office of Scientific Research, and the suit was developed by 1957 and actually became operational in vacuum chambers from 1957-1960. However, the suit was considered either too big or beyond the state of the art in *Mercury, Gemini* and *Apollo* competitions.

● **Future**—William Elkins, engineer in the Space Sciences Laboratory, is developmental project engineer on the hard-suit project. Also connected with the program is Dr. Robert Voas, formerly the astronauts' psychologist and now director of life sciences at the laboratory.

A number of advanced improvements are now being considered, De Graeve told M/R. These include:

—An advanced environmental control system, designed by Litton. This would be based on the liquid water principle, but the hard suit would be mounted with a multiplicity of heat exchangers, maintaining an "air-conditioned room" effect. As a result, no special undergarment would be needed; this would reduce donning time while increasing comfort and mobility. In addition, said De Graeve, it would eliminate the massive backpack, and lower the center of gravity of the suit.

—Impact and acceleration protection. Litton's objective would be to eliminate the astronaut couches entirely, by shockmounting the man in the suit in the capsule. Air bladders probably would be used for protection.

All other components necessary to make RX-4 a fully integrated suit. Litton would not expect to go into its own development of communications or biomedical instrumentation, unless some unforeseen development was pointed up. ■

Systems Group Improves Sperry's Competitive Position With DOD

SRSG, credited with winning up to $140 million in new business, finds role expanding in program definition phase

by Michael Getler

GREAT NECK, L.I., N.Y.—Sperry Rand Corp.'s Systems Group (SRSG), formed four years ago to bring more large systems business to the corporation, is also proving to be an efficient and economical management structure for operating in the new, sometimes costly, and always lengthy program-definition phases of Defense Department system procurements.

The group works on an expansion-contraction principle in which a small core of experts in diverse technologies can operate relatively inexpensively and efficiently in the pursuit of new business, while building into the organization the capability to rapidly expand to handle new proposal successes.

Since its inception, the group is credited with bringing in $135-140 million in new systems business to Sperry —business that officials here say in most instances would have eluded the firm. Officials note that SRSG's total effect on new business is difficult to trace, since new business often may be brought in by the group and then passed on to a division of the firm, or SRSG may have been instrumental in aiding a division in soliciting new business directly.

The value of SRSG to the corporation has also increased in the past 10 months. When the Sperry Gryoscope Co. divisions (see chart) were reorganized last October along technological lines from the earlier applications structure, SRSG became even more vital as a means to pull together these diverse technologies in pursuit of major systems contracts.

Also, perhaps equally important, SRSG is now viewed as insurance against a "new technology falling between the cracks." One of the functions being performed by SRSG now is the continuing study of new technologies, including those which are new to the industry as a whole as well as those which are at hand in some places but which are basically new to Sperry.

● **Line function**—The new technology studies are part of SRSG's more traditional role as a line organization directly responsible for new systems business.

Even more recently, the group has also taken on several staff functions, primarily in support of Sperry's New Business Review Board (NBRB).

The NBRB, formed in April, 1963, with less publicity than the major October shake-up, is in essence, the top new business decision-making group within the Sperry divisions of Sperry Rand. It passes on SRSG recommendations, controls major proposal funds, authorizes formation of proposal teams, makes use of business and technical analysis supplied by SRSG in its staff role, and in general guides the overall Sperry business plan.

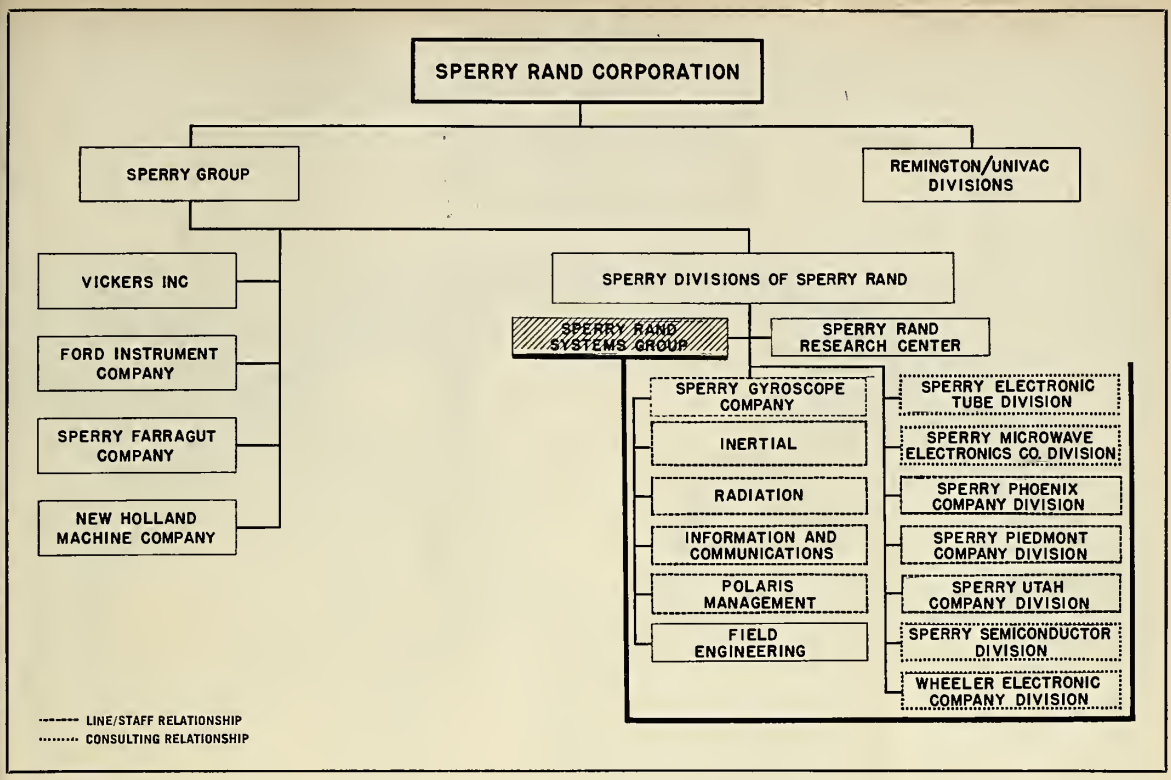
The 10-member board, which includes four executive vice presidents, was formed for reasons akin to the SRSG initiation: to deal with increasing system competition in the face of fewer programs, and the "telescoping," or stretchout, of the program definition phase.

It is because of this stretchout in defining potential new programs by the Pentagon that Sperry officials view SRSG as a major factor in being able to operate for long PDP and even pre-PDP phases without carrying the expense of an entire "systems division" along with it. It also does not inhibit the firm from going after a select number of small, and possibly profitless, studies which may eventually develop into large programs. Officials here say a firm has little prospect of success if it first hears about a project when the RFP's are issued.

● **Carte blanche**—Operating as a systems-seeking line organization, SRSG is able to tap the resources of the entire Sperry Rand organization when necessary, avoiding the continual maintenance of a "top-heavy staff" and without the peaks and valleys normally associated with the systems business.

While SRSG may probe the entire corporate resources, the group is basically a Sperry operation, reporting to, planning for, and proposing on systems business only for the Sperry divisions of the corporation. It may call, and has, on the Univac Div., for example, in areas where portions of the Remington/Univac side of the firm are deemed necessary; and planning information is always made available to other divisions.

The criterion is always where the lead activity is located. If SRSG is proposing on a major system where Sperry capabilities would take the lead, Univac may be called in as support on data-processing aspects. In instances where Univac capabilities are the major



portion of new business, that division will handle the proposal effort using Sperry divisions for whatever support they can provide, but without major SRSG involvement.

Another SRSG function is to act as a clearing house for proposals originating within the divisions and to recommend to the NBRB whether a division, the SRSG, or a newly created program office should take the lead in making the bid.

In general, all major systems proposals for the Sperry divisions involving the capabilities of more than one division are made via the SRSG. Where the program is less broad, a division usually gets the nod. This does not alter the individual divisions' responsibilities for their own market, proposal, and sales efforts.

Whatever structure is used for new systems business, "in all cases," Sperry reports, "all project personnel are administratively and physically pulled together."

Group officials stress that the situation does not introduce competition for new business between the divisions, but that it is aimed at helping bring new, and perhaps otherwise elusive, business in, based on an overview provided by SRSG. The intent of the group is, in fact, not to grow so large that it obviates the economies it seeks to achieve by operating with a relatively small core group.

● **Group's inception**—SRSG had its origins, officials told MISSILES AND ROCKETS, as the firm prepared for what it believes may become a future Navy and Air Force requirement for an advanced ICBM able to remain ready through long unattended periods. This concept, eventually to be known as Project Dormant, is still being studied by the services. Sperry, through SRSG, for the past two years has been funded for guidance systems studies. It is believed that some actual hardware development for this program is now being carried on at the firm.

Though formed for Dormant, SRSG's first major coup was capturing the ARIS (Advanced Range Instrumentation Ships) two-ship Air Force project (M/R, June 4, 1962, p. 34) which grew in contract value to be "on the order of $100 million."

The ARIS program is cited by Sperry as a prime example of its accordian-style expansion capabilities. The SRSG reportedly expanded from a staff of five to one of 350 persons "in a week or so," bringing in radar, navigation, and data-processing talent from various existing divisions.

● **SRSG work load**—Among other current major systems programs which SRSG is spearheading for Sperry is the Navy's *Advanced Standardized Missile System (ASMS)* for which the Navy has announced a number of pre-PDP team contracts (M/R, Aug. 17, p. 7). The Sperry team includes Univac and General Dynamics, with Sperry as prime.

SRSG also headed the Sperry team proposal on the Standardized Space Guidance System (M/R, Sept. 9, p. 16). First contracts to industry teams were let earlier this year (M/R, March 2, p. 17).

In addition, SRSG has also completed a recent study for the Navy on the Advanced Sea-Based Deterrent project, one which encompasses a larger spectrum of vehicles than does the Dormant program, according to informed sources. Sperry's role in this effort is centered on analysis of possible guidance, navigation and fire-control systems for various missile configurations.

● **Diversification**—While officials here say that current SRSG studies of totally new technologies must remain as proprietary information, they report to M/R that the group has begun to develop technologies basically new to Sperry in several fields.

For example, the firm is making a major effort in stabilization, control, navigation and guidance of space stations, and is betting heavily on the artificially-induced gravity types in comparison to zero-g systems. The firm will bid initially on the *Manned Orbiting*

Is this what most engineers mean when they say RELIABILITY?



A radar system that enables the pilot to deliver weapons on target—from high or low altitudes, in any weather, day or night.

That is reliability. The F-15 and R-14 radars have proven their reliability in both MTBF tests and actual operating conditions. These multimode, monopulse systems were developed by North American Aviation/Autonetics. F-15 equipped F-104 Starfighters are used by NATO, MAP and the Canadian Air Force. The R-14 is in the USAF F-105 Thunderchief. These radars have target-on-time impact capability with a high degree of accuracy. Autonetics supports these systems and ensures proper training, maintenance and modification with rapid service and technical assistance anywhere in the world. Now Autonetics is leading the industry into production application of microelectronics for even more versatile radar systems with still greater reliability. These are but some of the many achievements by engineers and scientists at Autonetics in integrated, cost-effective systems. These achievements set the standards of reliability for the entire electronics industry.

North American Aviation/Autonetics

Laboratory program in this area. SRSG has also won a NASA-Langley contract for a space station control system simulator (M/R, Aug. 3, p. 17).

In an area completely new to the firm, trajectory analysis, SRSG has also been successful in coming up with another NASA contract, an Orbital Determination Program (M/R, Nov. 4, p. 10), funded by Goddard and now in a follow-on contract phase. This same capability played a key part in the firm's proposal on the SSGS.

Under the heading of range instrumentation, the group will also go after funds in the *Apollo* tracking ships program (M/R, Dec. 16, 1963, p. 17), feeding in ARIS experience to the proposal now being prepared.

● **Staff assignment**—SRSG's new staff functions are primarily as a consultant and technical advisor to the NBRB, adding a second opinion to divisional forecasts and applying the operations-research and cost-effectiveness yardsticks to potential business investments. The group works closely with Sperry Rands's new research center in Sudbury, Mass. Key to the group's efforts is development of "master plans" in selected areas. Experts here attempt to set down the basic mission requirements of the services, develop the potential requirements, look for common subsystems and break them down to the component level, assess the firm's competence in these areas and that of the competition, and then develop a master plan for both corporate and individual division planning.

SRSG is now made up of about 100 to 150 core experts, each expected to make judgments on the next plateau in his field. Manager of the group is Sheldon O. Newman. The group, sort of a company within Sperry, is organized with both a technical staff and a program management staff, so that in an expansion phase a small nucleus of personnel can split away easily to set up its own operation with an existing program manager, engineering chief and planning group.

The ability to rapidly expand a group is no small problem, and the SRSG is not a panacea, as Sperry readily admits. They maintain, however, that by careful attention to programs, expansion may not have to occur overnight, and that there can in many cases be a more gradual build-up.

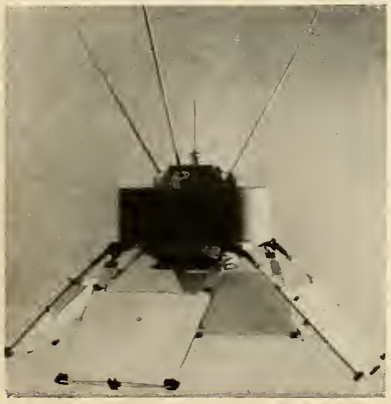
● **Management backing essential**—The ability to get the additional personnel quickly, explains Newman, has to be put on a priority basis established by top company management. "With a core group, at least we do not start from scratch. The way to do it," he told M/R, "is to select the people that are going to be needed early in the program, and get a formal commitment and agreement from the divisions in advance. In this manner," he explains, "it doesn't come as a shock to the divisions and they can plan their activities and not get hurt too badly. In addition, we always attempt to train back-up people.

"Where people are engaged in meaningful work, this system is never perfect," Newman reports. "This sort of thing does ease the burden, but we'll never go so far as to say that nothing gets hurt. We'd just be kidding ourselves."

While the Sperry Rand Corp. does not break down its corporate sales into divisional figures, it is believed that about 80% of the corporation's FY '64 total government sales of $522 million was made by the Sperry divisions. The government sales represented 47% of total Sperry Rand sales for the fiscal year ended March 31, 1964, down 2% from FY '63. Government sales were down by 13% from the previous year. Government backlog, at $599 million at the close of the firm's 1963 fiscal year, dropped to $515 million in FY '64.

As an indication of the amount of proposal effort that emanates from the Sperry divisions, a spokesman told M/R that in 1962 the firm made 600 individual proposals to maintain its business roughly at the same level as the previous year. ■

French Reveal D-1 Satellite Details



FIRST PHOTO of France's D-1 satellite, scheduled to be orbited next year. Satellite's most important function will be to test the Diamant vehicle's spacecraft launching capabilities. Weighing 17 kilograms, D-1 was designed for eventual geodetic uses and for studies of the space environment. Its successful orbiting would be the first by a nation other than the U.S. or USSR.

And is this what most engineers mean when they say APPLIED MICROELECTRONICS?



It is called the R45 Multi-Mode Radar.

The versatile R45 family of multi-mode radars takes full advantage of recent advances in microelectronics systems integration and computer programmed circuits analysis. It is another major achievement in "built-in" low total-life-cost by North American Aviation/Autonetics.

The R45 radar family was designed to fulfill a need for reliable, lightweight, easily maintained and versatile airborne systems at low cost. These building block systems weigh less than 100 pounds and have more than a 1000-hour inherent mean-time-between-failure rate in helicopter, transport and light attack applications. Basic K_u band frequency and 60 kw power can be varied to meet customer operational requirements.

Microelectronic R45 radar circuits are designed and verified by computer analysis, thus affording an unusually high degree of systems reliability, design integrity and simplicity. Standard circuitry and modular construction, employed throughout, add to systems adaptability. They are used, for example, in the R47 radar—a 30-pound low-altitude automatic terrain following sensor.

By selecting the necessary functional module blocks, specific operational modes may be added or subtracted.

This is but one more example of how the engineers and scientists at Autonetics are forging ahead in the field of applied microelectronics and total systems integration—another reason Autonetics is setting standards for the entire electronics industry.

North American Aviation Autonetics

B-3 Polaris Expected To Be Operational in '70

A-3 version due aboard ships by late this summer, with 25% greater reliability than A-2; Soviets could speed B-3

by Robert Lindsey

SUNNYVALE, CALIF.—Barring substantial Soviet advances in anti-missile or anti-submarine defense, the *B-3 Polaris* now is regarded as a weapon which will become operational about 1970.

Growth potential of the *A-2* and *A-3 Polaris* re-entry systems, longer than expected missile shelf-life and high confidence in the high reliability and penetrability of *A-3*, plus economic factors, indicate that the present system will not need replacement for at least five years, according to sources at Lockheed Missiles & Space Co. here, prime contractor for the missile system.

Other points revealed by LMSC missile system division officials in a briefing on current status of the *Polaris* effort:

—Despite its highly advanced design, the 2,500-n.-mi.-range *A-3 Polaris* will have a reliability confidence factor about 25% higher than the 1,500-mi. *A-2* model.

—Surplus *Polaris* vehicles may be used in a Dept. of Defense program to calibrate the nation's missile test ranges in a move to obtain more precise data on re-entry dynamics and missile accuracy.

—Lockheed is sponsoring a cooperative industry program based on its *Polaris* experience to develop low-cost, low-weight inertial guidance systems for advanced tactical missiles.

—The company is studying a variety of basic missile component improvements which would be applicable to the *B-3* or other advanced missiles.

—LMSC has a strong company-funded effort investigating the concept of a modular tactical missile, with interchangeable sensors and add-on propulsion units, which could be used for a wide spectrum of range and target requirements at minimum cost.

As reported previously (M/R, Jan. 13, p. 18), the *B-3 Polaris* would have a substantial increase in payload capacity over the *A-3*, used probably for a highly advanced re-entry system designed to enhance penetrability. Several inches wider than the present 54-in. *Polaris* missiles, *B-3* would nevertheless be capable of launch from existing submarines.

● **Russians determine**—Perhaps the biggest factor in deciding when the *B-3* is needed is projected Soviet anti-missile capability, vis-à-vis the capability of the *A-2* and *A-3* to penetrate these defenses.

Stanley Burriss, general manager of LMSC's missile systems division who has steered Lockheed's *Polaris* effort from the beginning, commented: "*B-3* as a system is admittedly a need by the Dept. of Defense. But due to a host of factors, largely economic, the question is not 'if' it is needed, but 'when.' Somebody must decide when it is economical to pull the *A-3's* out of the submarines and substitute *B-3's*.

"If we started tomorrow, we could have the *B-3* ready in three years, but it is a question whether it would be needed then. The shelf life of *A-1* and *A-2* missiles, for example, is turning out to be much longer than expected, so there is not as much pressure to replace them."

DOD is expected to release funds shortly for a $5-million project definition phase for the *B-3*. It is still undecided, according to Lockheed sources, whether present contractors will be asked to do the work or whether there will be an industry-wide competition.

● **A-3 lessons**—Meanwhile, the final half-dozen developmental missiles have been tested in the *A-3* program, and that new missile achieved operational status on schedule only this month. Burriss said the *A-3* was brought in with 15% fewer flights than originally scheduled because the program managers saw more than a year ago certain problems were not turning out as serious as forecast.

Reviewing the *A-3* development effort, which pioneered a new high-specific-impulse solid propellant, two-stage fiber-glass casings, the Mark II light-weight guidance system, fluid-injection thrust-vector control and many other advanced techniques, Burriss said, "there was no really major problem that came up during the testing to cause re-design. There were a lot of little things that were frustrating; in fact, in the early tests (when five out of the first six shots failed to go the programmed distance) there was no pattern to the failures—they were all caused by little things—and this caused some headaches."

Burriss disclosed that several of the early failures were caused by bugs in the weapon's new high-voltage exploding bridge-wire system. However, he added that this advanced pyrotechnic system, being less sensitive to transient effects, is safer and more reliable than the low-voltage igniters and explosive bolts of *A-1* and *A-2*.

In all, Burriss said, the *A-3* will have a reliability confidence factor "at least 25 to 30%" more than *A-2*, reflecting experience of the program. The *A-2* had a similar advance over the *A-1*, the 1,200-mi.-range interim version of *Polaris*.

In assessing total penetrability of the system, Burriss said he would prefer to have more precise data on certain aspects of the flight tests. "Range instrumentation often is not up to providing what we would like to know; we have to settle for what we can get," he said, indicating re-entry phenomena

GD Gets B-3 Study

THE NAVY'S Bureau of Ships recently awarded a $700,000 letter contract to General Dynamics/Electric Boat division for engineering services to assist in the program definition phase of submarine conversion for the *B-3*.

BuShips said the services should lead to defining the ship-weapon system interfaces for the advanced *Polaris* missile as shown in the installation report of the B-3 RFP committee.



STANLEY BURRISS, general manager of LMSC's missile systems division, bosses Polaris program.

is one of the areas in which he would like more precise data. However, he added, one program DOD is considering for veteran *Polaris* missiles removed from operational submarines is an effort to check reliability of the ranges and give practice in acquiring re-entry data.

Burriss said he has no doubts about the capability of the missiles to accomplish their mission. While there is a statistical chance a small fraction of the missiles would not reach target, he implied there is ample target redundancy to overcome this relatively minor contingency.

"We built the *A-1* with a rather pessimistic attitude about performance and shelf life and they were targeted accordingly," he said. "With the *A-2* and *A-3* there is a great improvement in the number of missiles that would get from the submarine to their targets."

• **Constant upgrading**—As for the future of *A-3*, Burriss continued, "there is a whole bank of ideas we might consider . . . value engineering, cost reduction and so on. But the Navy and ourselves, wisely I think, have decided not to make any change within the heart of the system. We cut design changes out of *A-3* a year ago."

Studies are continuing on improving accuracy and survivability of the missiles, however. A few *A-2* and *A-3* missiles have been allotted for firing over the Western Test Range toward Kwajalein Island's *Nike-Zeus* radar complex to determine detectability of the missiles and the efficacy of penetration aids.

Burriss said LMSC has a continuing program, partially funded, which looks at follow-ons to the *A-3;* the *B-3* grew out of this research. He disclosed an intensive program studying "about six or eight problem areas" which apply to design of *B-3* as well as other advanced missiles.

"For example, we see a need in the industry for a method to take a connector and visually see if all pins are properly seated. This may sound like a simple thing, but it's one of the biggest reliability problems we have. We need some method to visually check connectors.

"Another area we're looking at is a self-contained checkout system for missiles. A missile might have a modest computer built into it and the missile would check itself, without a plug-in system." Also under scrutiny in the program are improved telemetry techniques, microelectronic applications, better instrumentation and transducers.

Growing out of these components studies for advanced *Polaris* systems has been a Lockheed-sponsored cooperative study of low-cost, low-weight inertial guidance systems. "We and our partners in the guidance industry are taking a hard look at systems which might reduce the cost of inertial systems by a factor of 10." While technology would be based on experience in the *Polaris* program, he said the lower accuracy requirements of a tactical missile guidance package should provide a key for substantial cost savings. Honeywell, Lear Siegler and AC Spark Plug are among the participants.

"With relaxation in accuracy requirements," Burriss continued, "it may be possible to develop an inertial system $\frac{1}{10}$th, perhaps $\frac{1}{20}$th the cost of a *Polaris* guidance system." Among the areas covered in the study are simplified accelerometers, gyros, weight reduction using advanced materials and systems with easy maintenance.

• **Tactical insurance**—With wind-up of the *Polaris A-3* development, and the probability that *B-3* won't become a full-bore effort for some time, LMSC's missile system division is turning heavily to research on tactical missiles.

"We've taken the modular approach," he said. As envisioned, a basic missile core containing guidance and control systems could be used for a variety of missions by interchanging sensors and warheads and by adding or subtracting propulsion modules. ■

Ranger Photos Reveal No New Lunar Vehicle Design Difficulties

GM work on lunar rover, GM/Boeing MOLAB study, to assume likelihood of encountering rough terrain

by Rex Pay

SANTA BARBARA, CALIF.—Engineers involved in lunar roving vehicle programs at GM Defense Research Laboratories, General Motors Corporation, see no new problems in lunar vehicle designs after a preliminary assessment of the *Ranger* photographs released to the press.

Absence of large fissures and cracks make vehicle design easier, since the ability to cross crevasses can be traded for obstacle-climbing ability. The engineers point out that although no sharp vertical faces were evident in the large-scale pictures, such obstacles probably would be met in other parts of the Moon.

The surface roughness (if it existed) in the area of the close-up *Ranger* pictures is indicated to be less than 1.5 ft. in mean height. The pictures also suggested that, on a larger scale, mean slopes outside of craters were probably less than 23 degrees. This could still be a very rugged landscape. A terrestrial example of the sort of conditions that would perhaps photograph in the same way are portions of the Bonita Lava Flow near Flagstaff, Ariz.

Don Friedman, Lunar Program Manager, emphasized that one important result of the *Ranger* pictures will be to provide new data on lunar meteoroid influx by extending downward by two orders of magnitude present crater distribution statistics.

GM Defense Research Laboratories has recently reached the final stages of a phase 1 study contract for NASA on a *Surveyor Lunar Roving Vehicle*. GMDRL is also teamed with Boeing in a NASA contract to study a *Mobile Lunar Laboratory* (*MOLAB*).

● **Six-wheeler**—General Motors' work on lunar vehicles has concentrated on articulated six-wheel types with three flexibly connected axles. This configuration, with 3-ft.-dia. wheels, can climb a 5-ft. smooth vertical step and has gone up yielding sand dunes that are theoretically unclimbable. The vehicle used in these tests was 12 ft. long by 5 ft. wide.

The wheels General Motors has been investigating are very balloon-shaped, almost spherical, and are made up of flexible spring wire covered with steel mesh. Such a wheel deflects like a low-pressure tire and exerts about 0.1-psi ground pressure, providing good flotation characteristics and good soft-ground crossing capability. The soft wheels tend to envelop small hard obstacles.

The 66-lb. test vehicle, exercised in various types of rugged terrain in the United States, would be capable of carrying 360 lbs. on the Moon.

The amount of dust or loose material on the Moon is of considerable significance to the vehicle's load-carrying capability, because a deep dust layer consumes more power.

In its configuration for *Surveyor*, each of the vehicle's three axles would carry an equipment box. They probably would be shaped so that the three could fold together to form a compact package for rocket transport. The wheels are likely to be collapsible down to thin discs.

Both front and rear axles may be steerable. The front axle would carry the *Surveyor* binocular television system, the middle axle would carry a radio receiver and a tall mast surmounted by an omnidirectional antenna, and the rear axle probably would carry the power supply package.

In vehicles that have been tested, all axles are powered and front and rear axles have wagon-type steering. Remotely controlled driving tests have been carried out with a 3-second delay in the radio control system to stimulate the time-lag of Earth-lunar transmission. The antenna mast probably would be inflatable. ■



INFLATED vertical mast on GM lunar rover carries an omnidirectional antenna.

Surveyor-Linked Lunar Rover Seen Feasible

THE *LUNAR Roving Vehicle* is being studied with a view to its use after 1966 in the 10 follow-on *Surveyor* missions. These missions are being evaluated to see how they can best support the *Apollo* requirements for landing-site certification, while continuing the lunar exploration program.

A *Surveyor* payload that disembarks after landing and roves over a potential *Apollo* landing site, surveying soil bearing strength and general topography, appears feasible, JPL reports, and will give site certification to standards of the Office of Manned Spaceflight.

The *Surveyor Lunar Roving Vehicle* would weigh about 150 lbs. and be able to traverse terrains unacceptable as *Apollo* landing sites. It would be completely controllable from Earth, be able to survive the lunar night, and have a range greater than 30 km.

Cockpit Unit Will Allow Gemini Astronauts To Alter Flight Plan

IBM system, part of advanced guidance computer, permits manual changes to be made independently of ground stations

A NEW *GEMINI*-COCKPIT data-insertion unit will allow astronauts to manually enter a wide range of information into their spacecraft guidance system and, for the first time, give them the ability to alter the flight profile of their vehicle independently of ground stations.

The Manual Data Insertion Unit (MDIU), developed by IBM's Federal Systems Div. for prime contractor McDonnell Aircraft Corp., is a part of the advanced guidance computer for *Gemini*, also being developed by the division.

The IBM unit will permit *Gemini* pilots to manually change the basic data used by the guidance computer in controlling the flight. Should weather conditions deteriorate, for example, in the originally planned landing area, the astronauts will be able to re-program their computer guidance system to aim for an alternate touchdown point by entering new latitude and longitude coordinates with the data-insertion unit.

● **Data variable**—Through two small panels in the cockpit, the astronauts can introduce 20 categories of information into the computer, including: updated altitude and velocity from radar tracking stations, new time to retrograde in the event of a shortened mission and changes in air density coefficients affecting re-entry guidance. Additionally, the unit permits double-checking of information already stored in the computer.

Current *Gemini* plans place great emphasis on the unique capabilities of the human operator, pointed out C. D. Babb, manager of IBM's Space Programs Office. In *Gemini*, he stressed, NASA will have a spacecraft that can stay aloft for two weeks or rendezvous with other orbiting vehicles on shorter missions. The *MDIU* will contribute significantly to the evaluation of human performance under the stress of long and complex space flight.

● **Simple panels**—Cockpit elements of the MDIU consist of two small control panels. One contains push buttons numbered "0" through "9". The other has a seven-digit numerical display window and three buttons labelled "read out," "cancel," and "insert."

To enter new information into the vehicle guidance system, *Gemini* pilots will compose a seven-digit number, the first two digits of which specify the address in the computer memory where the information is to be stored. The seven-digit number will then be punched in on the panel containing the numbered push buttons. The number will next appear on the visual display window of the second panel. If correct, it can be entered into the system by pushing the insert button. If incorrect, it can be erased by means of the cancel button, and the correct figure reset.

To obtain information already stored in the computer, the astronauts will punch in two digits to indicate the computer address where the desired information is stored, then activate the readout button. The requested data will then appear in the visual display window. ■



GEMINI CAPSULE Manual Data Insertion Unit developed by IBM will permit change of flight profile and guidance computer program without ground aid.

TIMM Components Work Throughout High-Intensity Radiation Bombardment

Tape recorder amplifiers described as first subsystems using vacuum tubes to function in pulsed gamma-neutron environment

by Rick Kiefer

ALBUQUERQUE, N.M.—Initial successes in the development of electronic circuitry capable of operating efficiently for long periods in the presence of strong nuclear radiation have been reported by General Electric here as a result of work for the Air Force.

Two miniaturized tape-recorder amplifiers using GE-developed TIMM (Thermionic Integrated Micro-Module) components recently became the first subsystems employing vacuum tube circuitry known to function continuously while being bombarded with pulsed high-intensity gamma-neutron radiation. The tests were performed to measure temporary or "transient" harmful radiation effects. Results so far support GE predictions (M/R Sept. 9, 1963, p. 18) of the high pulsed-radiation tolerance of their ceramic tubes.

Henning L. Olesen of GE's Re-entry Systems Department said vacuum tubes are basically resistant to long-range or permanent effects caused by neutron radiation. But the recent testing, which was performed here in the Sandia Laboratory's "Godiva" pulsed reactor facility, "indicated we are finally on the right track to developing electronic hardware resistant to both transient and permanent radiation effects."

The amplifiers, developed as part of an Air Force Weapons Lab contract, are the first subsystems to be developed for operational use using TIMM's. Olesen is project leader for this effort, which is to develop a radiation-resistant tape-recorder system.

● **TIMM concept**—A family of TIMM components has been developed by GE's Owensboro, Ky., receiving tube department to perform the same functions as other vacuum tubes and semiconductors. A significant feature of TIMM components is that they operate with high performance at 580°C.

The TIMM elements themselves are miniaturized heaterless ceramic vacuum tubes. Emission is initiated by heating the entire device to 580°C. For a typical TIMM system, according to GE, power consumption is 10 times less than for the ordinary filamentary vacuum tube system. The present TIMM family includes diodes, triodes, resistors, capacitors, and will eventually include pentodes.

It was this high-temperature feature that aided the TIMM amplifiers in tolerating the pulsed radiation. The molecular activity generated by the pulsed radiation was nearly identical to the operating temperature normally required by TIMM's.

Ultimate applications of these research efforts include development of electronic circuitry to control the power plants of future nuclear-propelled spacecraft and to provide missiles with greater immunity from anti-ICBM nuclear blasts.

● **Test approach**—A remotely located instrumentation trailer fed a 100-kc sine-wave signal to the TIMM amplifier inside the reactor. The signal was amplified and fed back to the trailer, where it was recorded on a 500-kc recorder.

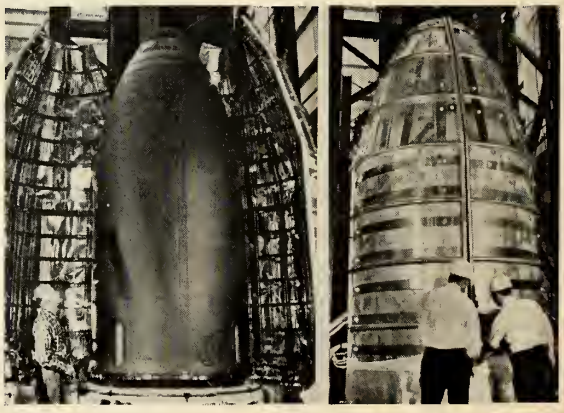
Circuit operation experienced no interruptions during the test, Olesen said. The only noticeable effect was a 20-db degradation in signal strength.

Olesen noted that the test results could be compared closely with previous vacuum-tube tests at the facility because the same reactor has been used extensively by industry and government agencies for testing radiation resistance of other components.

The test amplifier consisted of an open-sided box-like, ceramic chassis, measuring approximately 2½ x 1¼ x 1 in., in which were mounted platinum heating wires, the TIMM circuit elements and associated wires and terminals. This module was packed in a layer of Kaowool insulating material to retain the heat generated by the heating wires. Layers of molybdenum foil, surrounding the Kaowool, turned back what little heat penetrated that layer of material.

All this was installed in a stainless steel cylinder, which was sealed and evacuated to a vacuum of 10^{-7} torr. Removal of air from the cylinder eliminated surface-leakage currents that otherwise would have resulted from air-ionization during the high-intensity radiation pulse. ■

Mariner Shroud Displayed



BULLET-SHAPED shroud, left, will protect Mariner C spacecraft in Earth's atmosphere during late 1964 launch. Lockheed Missiles & Space Co. is contractor for shroud and also for heat test oven, shown open at left and closed at right.



FLAME MOTOR is fired in recent test of aerodynamic shapes and materials at Martin-Orlando.

space support

Martin Facility Testing Ablatives

Speculation links Orlando FLAME installation with Sprint development; can accommodate test specimens up to 10 in. dia.

by William Beller

ONE OF THE FIRST of the advanced test facilities for getting data useful for very-high-acceleration booster programs recently went into operation at Martin-Orlando.

There's speculation that the new facility was specifically developed to help get materials information for *Sprint*, the high-acceleration missile the company is developing for the *Nike-X* anti-ICBM system.

Martin officials declined, however, to relate their facility to any hardware program beyond saying it was built to test ablative coatings and heat-shield materials "for a severe set of flight circumstances." A further use is to correlate its data with flight-test data.

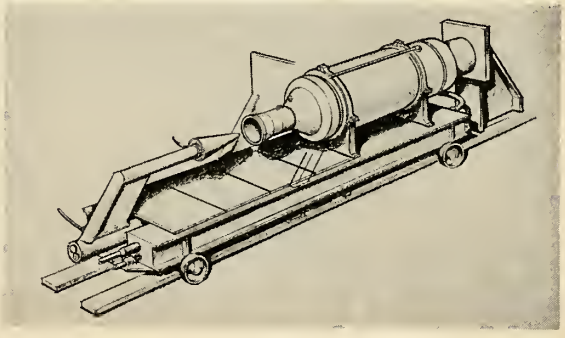
The acronym FLAME was chosen as the name for this Facility Laboratory for Ablative Materials Evaluation, reputed to be the largest of its type in the free world. The gas generator whose exhaust is the test medium for the materials work is a powerful rocket motor that in a flight version might itself be able to power a high-acceleration missile.

The motor, designed jointly by Martin-Orlando and Thiokol Chemical Corp. and produced by Thiokol's Alpha Div. Huntsville Plant, generates a stabilized and essentially particle-free gas. Expelled under high temperature and pressure, the gas flows for about 10 seconds, enough time to allow sizable test specimens to attain aerothermal equilibrium.

The nearly 17-in.-dia. exit plane of the gas generator permits lengthy cylindrical specimens up to 10 in. in diameter to be tested in an almost clean exhaust, as well as flat plates 36-in.-sq.

Burning a 2,500-lb. grain during its firing, the motor's metal casement and nozzle develop a mass flow rate of 250 lbs. per second and temperatures of 5,000°F. These characteristics lead to the following aerothermodynamic conditions provided by FLAME, conditions seemingly adequate for gathering data for high-acceleration boosters: Mach number, 4.27; stagnation enthalpy, 1,-790 BTU/sec.; gas velocity, 8,250 fps; total temperature, 4,600°R; duration, 10 to 12 seconds.

With two FLAME cells operating, Martin officials say they can refill the motors and run one to two tests a week on a continuous basis. Because FLAME is a unique facility and time on it will



DRAWING OF FLAME facility clearly shows relation of test specimen to exhaust area. Motor generates temperatures in excess of 5,000°F.

probably be available, Martin is offering its use "to principal aerospace industries on a scheduled basis for research and development programs."

● **Before FLAME**—The facilities for FLAME, built in a four-month period, were designed to be simple and flexible. Up to the time they were constructed, Martin could not find a materials testing facility for extreme environmental conditions that did not fall short in one of the desired characteristics.

To overcome this lack, the company designed its facility around a rechargeable, solid propellent gas generator. Another factor that figured was the inherent ease in changing the character of the gas exhaust simply by changing the propellant formulation.

In this way, then, a wide spectrum of gas environments could be simulated.

Martin also saw the need to go to a high-pressure combustion chamber. The company already had results from developmental tests of blast-deflector and launch pad materials that had been exposed to the exhausts of end-burning solid propellant generators operating at up to 1,000 psi chamber pressure. These data were the basis for the design calculations which indicated that for the extended conditions of extreme environments, the new gas generator would have to be a reloadable vessel able to withstand 5,000 psi chamber pressure.

In addition, the new casement would burn a cored propellant.

The resulting laboratory, built in a remote location on company property, comprises two test bays, a barricaded control blockhouse, hard-surfaced roads to main plant areas, protective buttresses 100 ft. long and 20-ft. high, instrumentation booths and a ready magazine for pyrogens.

● **Testing technique**—Because up to 225 sq. in. can be irradiated by the exhaust jet of the generator, it is possible to get data on several types of test programs during a single firing.

Typically, complete flight bodies with nose cones, control vanes or various other experimental shapes or materials can be accommodated on a single test. For instance, launch-pad protective coatings, various re-entry ablative and insulation materials as well as several aerodynamic configurations may all be combined in one firing. This is one of the reasons Martin claims this facility is economical as well as versatile.

FLAME can provide from 100 to 200 channels of data to measure temperature (thermocouples, calorimeters), pressure, strain and vibration. Readout is by oscillograph, but facilities are being installed to provide 50 channels each for temperature and pressure on magnetic tape ready for computer entry.

Sensors in the test specimen are connected by means of wires run inside the water-cooled specimen holder or sting. Recording equipment is installed in a special reinforced concrete room at the front corner of each test cell, and is controlled manually or automatically in the control blockhouse.

Still and both regular and high-speed motion picture cameras can provide black-and-white and color documentation of all firings.

● **Gas-generator design**—The motor is 6 ft. long and 40 in. in diameter, and is the largest and most powerful ever used in such materials tests. The refill motors are a pre-cased grain in a filament-wound glass fiber case. During firing, the case also serves as an insulator.

The gas generator and sting are mounted on a flat bed, which, in turn, is mounted on rollers. Although the thrust block is designed for 100,000 lbs., a safe 60,000 lbs. is generated by typical propellants. The one used for some of the firings has been an ammonium perchlorate grain, weighing 2,540 lbs., 39.02 in. in diameter and 66 in. long with a 6-in. web thickness.

After each firing, the thrust mount is removed and the bed and expended motor are rolled into the cell for refurbishing and reloading. ■



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Mergers and Acquisitions

Rocket Research Corp., Seattle, Wash., has acquired the assets and personnel of Micro Instrument Corp., a specialist in precision machining and manufacturing of miniature instruments and components for the aerospace industry. Micro has been closely associated with Rocket Research as a subcontractor for three years. . . . *General Time Corp. has agreed to purchase for about $1 million the research and development division of Elgin National Watch Co. The Elgin division has been developing timing systems for use in space exploration programs, including Apollo. The new activity will be made a part of General Time's Acronetics Div.* . . . Model Engineering and Manufacturing Corp., Huntington, Ind., has merged its Montek and Courter divisions into a new group to be known as Memcor-Midwest. The new division will be active in the fields of industrial control, communications, electro-mechanical devices and production components for military and industry. . . . *Servonic Instruments, Inc., a Costa Mesa, Calif., subsidiary of Gulton Industries, has acquired Glass Technology Laboratories, also of Costa Mesa. Servonic plans to assimilate the connector capability of GTL into its production of precision transducers. GTL recently developed a new process for fabrication of flat glass packs for microcircuits.* . . . Jamieson Industries shareholders have approved acquisition of the company by Genisco Technology Corp. (M/R, Aug. 3, p. 35).

Experts View Future of Electronics

The ability to adapt to and create change will be required of the electronics industry if it is to offer financial growth in the future, according to industry spokesmen at a meeting of the Los Angeles Society of Financial Analysts. At the meeting on the subject of "The Business Outlook for Electronics," the financial representatives heard from such electronics leaders as Max Leher of Radio Corp. of America; Dr. Daniel E. Noble, Motorola, Inc.; and Donald H. Putnam, Giannini Controls Corp. Putnam noted that future opportunities are open to the industry in industrial as well as military markets. Although growth rates are not as rapid for industrial products as for military sales, "industrial business is usually solid, and certainly the profit margins on established industrial products are a great deal higher than on Federal business," Putnam said. On the other hand, he said, Federal business offers the advantage of being receptive to new ideas and is willing to gamble on unproven technical concepts. This outweighs the traits of low profit margins and sensitivity to political factors, he said.

New Activities

Photosystems Corp. has been formed in Lido Beach, N.Y., to design, develop, and manufacture specialized photographic equipment for research in government and industry. First commercial product will be a camera, for delivery in 1965, capable of recording from 10,000 to 1,000,000 pictures per second. Richard A. Hayes, formerly engineering vice president of Photronics Corp., is president of the new firm. . . . *Thomson Electric Welder Co., Inc., Lynn, Mass., producer of resistance welding equipment, has formed a new division to engage in the development, manufacturing and marketing of electron beam and vacuum inert arc welding equipment. The division will be known as EBC/Thomson.* . . . MB Electronics, a division of Textron Electronics, Inc., has formed a sales subsidiary, TE Sales, to represent it in New York City; Nassau, Rockland, Suffolk and Westchester counties in New York State; and in Delaware, New Jersey and eastern Pennsylvania. TE Sales will handle the MB line of vibration test systems, vibration- and shock-absorbing materials and universal test machines. The new sales organization replaces the V.A. Snyder Co., which formerly covered the area for MB Electronics.

Bell Aero Reorganizes Top Management

Bell Aerosystems Co., Buffalo, N.Y., plans to effect by Sept. 1 a major reorganization of its top management, including the creation of a new executive vice president post. The realignment is designed along functional rather than divisional product lines, and is to include consolidation of the Aerospace/Rockets and Avionics divisions. The executive vice president will be responsible for day-to-day operations and to oversee five subordinate vice president-level operations. The executive will report directly to Aerosystems President William G. Gisel.

International

General Precision Equipment Corp.'s subsidiary, General Precision, Inc., has entered an agreement with the Tokyo firm of Toko, Inc., to manufacture, sell and distribute Toko's new thin-film, woven-wire memory planes in the U.S. . . . *Anocut Engineering Co., Elk Grove Village, Ill., has licensed Hitachi Ltd., Tokyo, to make, use and sell Anocut electrochemical machining equipment in Southeast Asia.* . . . MB Electronics, New Haven, Conn., has acquired the German balancing machine manufacturer, Trebel-Werk G.m.b.H. The firm will be known in the future as MB/Trebel and will be operated as a subsidiary of MB.

Missile/Space Facilities

Dow Chemical Corp. has established administrative and engineering offices for Cape Kennedy-MILA operations in Titusville, Fla. The firm recently received a $1.4-million contract from NASA to provide facilities engineering support services for the MILA operation. . . . *Cubic Corp., San Diego, Calif., has delivered the communications link in a system designed for a new U.S. Air Force Tactical Air Command mission. The program is to demonstrate the operational capabilities of instantaneous transmittal of reconnaissance information from airborne aircraft to the ground.*

AWARDS

AIR FORCE

$3,290,000—**Martin Marietta Corp.,** Littleton, Colo., for *Titan II* missile range safety kits.

$3,243,619—**Atlantic Research Corp.,** Duarte, Calif., to develop test vehicles for re-entry vehicle systems.

$2,750,000—**Martin Marietta Corp.,** Baltimore, for advanced space re-entry tests.

$2,000,000—**General Dynamics Corp.,** San Diego, for continued work on *Nike-Zeus* target missiles.

$1,722,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., for communication equipment and services.

$1,541,626—**General Motors Corp.,** Milwaukee, Wis., for work on the guidance system of *Titan II* missiles.

$624,791—**Goodyear Aerospace Corp.,** Akron, Ohio, for repair and modification of *Mace* missile airframe.

$466,330—**Martin Marietta Corp.,** Baltimore, for repair and modification of *Mace* missile system.

$55,000—**Syracuse Univ. Research Corp.,** Syracuse, N.Y., for an S-band discriminator.

$12,445—**Aerospace Research, Inc.,** Boston, for the fabrication of a UHF random noise source.

ARMY

$2,000,000—**Ventura Div., Northrop Corp.,** Beverly Hills, Calif., for two contracts for continued production and flight services of the AQM-38A (RP-76) rocket-powered drone.

$717,000—**J. R. Francis General Contractor, Inc.,** for construction of addition to Lunar Excursion Module preparation building at NASA's Manned Spacecraft Center test area.

$517,000—**Electronic Engineering Co.,** Santa Ana, Calif., for precision electronic timing and synchronization equipment for satellite tracking cameras.

$300,000—**Microwave Associates, Inc.,** Burlington, Mass., for two contracts for travelling wave tubes and magnetrons.

$65,958—**Raytheon Co.,** Research Div., Waltham, Mass., for theoretical laser research.

$56,970 **Raytheon Co.,** Andover, Mass., for repair parts for *Hawk* missile system; also $255,338 for field maintenance engineering services for *Hawk* missile system.

$31,170—**A. C. Chock,** Oahu, Hawaii, for construction of satellite communication facility, Helemano Radio Receiving Station.

Foote Mineral Co., Exton, Pa., for research and development leading to production of optical quality glass which will provide shields for workers exposed to nuclear radiation (amount undisclosed).

NAVY

$13,189,223—**Maxson Electronics Corp.,** Great River, N.Y., for production of AQM-37A missile targets over five years. The first year's amount is $3,751,044.

$3,081,078—**FMC Corp.,** Minneapolis, Minn., to make launching systems for *Terrier* missile.

$1,191,156—**Defense Electronics, Inc.,** Rockville, Md., to design and manufacture two instrumentation packages for use in support of *Polaris* missile tests.

$500,000—**Microwave Associates, Inc.,** Burlington, Mass., for miniature beacon magnetrons used in missile programs.

$31,600—**McGall Constructors,** Point Mugu, Calif., for relocation of technical simulation equipment at the Naval Missile Center.

NASA

$2,200,000—**Carrier Air Conditioning Co.,** Syracuse, N.Y., to provide a special ground-based environmental control system for the *Saturn V* manned moon rocket.

$511,000—**American Machine & Foundry Co.,** Advanced Products Group, Alexandria, Va., to design, develop, and build a device to detect and analyze solar X-ray radiation.

$499,441—**Avco Corp.,** Research & Advanced Development Div., Wilmington, Mass., for continuation of resistojet research and development program.

$317,456—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., for development study to ascertain compatibility of certain *Atlas* propulsion components with FLOX.

$296,636—**Martin Marietta Corp.,** Baltimore, for a spacecraft propulsion study for manned Mars and Venus missions.

$250,000—**Dunlap and Associates, Inc.,** Darien, Conn., for a study on automation and man-machine relationships in pre-launch testing and countdown for manned space vehicles.

$200,000—**U.S. Air Force,** for services and materials to provide a range recovery ship for period of Aug. 1, 1964, through Oct. 31, 1964 at Eastern Test Range.

$199,703—**Douglas Aircraft Co.,** Missile and Space Div., Santa Monica, Calif., for a study of conjunction class manned Mars trips.

$141,846—**Bendix Corp.,** Research Lab., Southfield, Mich., for development of an all-fluid amplifier for liquid rocket application.

$102,596—**Collins Radio Co.,** Dallas, for services and materials for fabrication of two FRW-2A 500-watt command destruct systems.

$99,650—**Bethlehem Corp.,** Bethlehem, Pa., for a horizontal type environmental test chamber.

$96,142—**TRW/Space Technology Labs,** Cape Kennedy, Fla., for manpower requirements for rocket booster launch operations.

$77,830—**General Electric Co.,** Valley Forge, Pa., for a study of nuclear Brayton cycle power system.

$74,892—**Research Institute for Advanced Studies (Martin Co.),** Baltimore, for biochemical research into the determination of the possible forms of extraterrestrial life.

DEFENSE ATOMIC SUPPORT AGENCY

$56,000—**American Nucleonics Corp.,** Glendale, Calif., for a study relating to plasma antennas in a nuclear environment.

INDUSTRY

$356,000—**Sperry Rand Corp.,** Sperry Utah Co., Div., Salt Lake City, from Johns Hopkins Univ., Applied Physics Lab., Baltimore, for flight testing aboard *Sergeant* missiles an experimental model of a simplified inertial guidance system under consideration for the Navy's landing force support weapon.

$350,000—**General Telephone & Electronics,** Sylvania Electric Products Inc., New York City, from Bell Telephone Laboratories, New York City, to design, develop and produce electronic equipment more rugged than that in existing missile systems.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Bureau of Naval Weapons
Washington, D.C. 20360

BuWeps intends to solicit a proposal from Vitro Laboratories, Silver Spring, Md., for services and materials necessary to conduct research and development in weapon systems installations for air-launched and ship launched weapons. For information only, RFP not available.

Nike-X Project Office
Army Missile Command
Redstone Arsenal, Alabama

A proposal was solicited from General Electric Co. for additional research and development services on "discrimination on criteria identification and evaluation." Subcontractors inquire to General Electric Co., Missile & Space Div., P.O. Box 8555, Philadelphia.

George C. Marshall Space Flight Center
Attn: PR-ES R. A. Parsley
Huntsville, Ala. 35812

Study of indicial load effects on multistage missile systems will be negotiated with the Midwest Research Institute, Kansas City, Mo. For information only, RFP not available.

Procurement and Production
R&D Contracts Division
Laurence G. Hanscom Field
Bedford, Mass. 01731

Performance of further research of various aspects of the particulate environment of near-Earth space will be negotiated with American Science and Engineering Inc., Cambridge, Mass For information only, RFP not available.

Chief Contractor Relations
Space Systems Division
AF Unit Post Office
Los Angeles, Calif. 90045

Contract for repair of 31 backpacks for space suits of the *Titan III* program for Atlantic Missile Range will be negotiated with Air Research Mfg. Co., Torrance, Calif. For information only, RFP not available.

Bureau of Naval Weapons
Washington, D.C. 20360

Job order contract for repair and modification of missile test and readiness equipment MK 6 will be negotiated with Lockheed Aircraft Corp., Lockheed Electronics Co., Metuchen, N.J. For information only, RFP not available.

Bureau of Naval Weapons
Washington, D.C. 20360

Northrop Corp., Nortronics Division, Anaheim, Calif., will be solicited to provide miscellaneous items of repair parts for missile test and readiness equipment MK 7. Small business firms and others interested in subcontracting should contact Northrop directly. Reference P.R. No. SP 274-10-65—BuWeps Synopsis No. 103-65.

Bureau of Naval Weapons
Washington, D.C. 20360

Job order contract for modification and repair of *Polaris* missile components and subassemblies will be solicited from Lockheed Missiles and Space Co., Sunnyvale, Calif. For information only, no RFP available.

Bureau of Naval Weapons
Washington, D.C. 20360

BuWeps intends to solicit a proposal from Hercules Powder Co., Allegany Ballistics Laboratory, Cumberland, Md., to provide sustaining engineering inherent with the design, test and evaluation of rocket motors and components for surface missile systems and reports. For information only, RFP not available.

Bureau of Naval Weapons
Washington, D.C. 20360

Polaris missile tactical field services and engineering support. BuWeps will solicit a proposal from Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Sunnyvale, Calif. For information only, RFP not available.

National Aeronautics and Space Administration
Flight Research Center
P.O. Box 273
Edwards, California 93523

Negotiations will be conducted with Ampex Corp., Redwood City, Calif., for magnetic recorder/reproducer system. RFP not available.

National Aeronautics and Space Administration
Wallops Station
Wallops Island
Accomack County, Va.

Service and material for design, development, fabrication and installment of a digital range modification system. RFP P-1005; due date Sept. 25, 1964.

Procurement and Production
R&D Contracts Division
Laurence G. Hanscom Field
Bedford, Mass. 01731

Negotiations with Parametrics, Inc., Waltham, Mass., have been begun on the design, development and construction of one rocket-borne charged-particle system for the measurement of environmental protons and electrons at high altitudes.

NASA, Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

Negotiations will be conducted with the Bendix Corp., Davenport, Iowa, for procurement of an additional cryogenic storage vessel and modification to contract NAS 9-2978. For information only, RFP not available.

NASA, Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

NASA-MSC intends to negotiate a contract with Reynolds Industries, Inc., Santa Monica, Calif., for design, fabrication and testing of special-purpose electrical connectors. For information only, RFP not available.

NASA, Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

Preliminary design and program definition for an *Apollo* guidance and navigation backup computer. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with International Business Machines Corp., Owego, N.Y. RFP BG53-64-5-4-P.

NASA, Manned Spacecraft Center
General Research Procurement Branch
2101 Webster-Seabrook Road
Houston, Tex. 77058

Negotiations will be conducted with the AVCO Corp., Wilmington, Mass., for ablative material to be used for a micrometeroid impact study program. For information only, RFP not available.

Directorate of R&D Procurement
Systems Engineering Group
Research & Technology Division
Wright-Patterson AFB, Ohio

Negotiations will be conducted with Texas Instruments, Inc., Dallas, for a research program on gallium arsenide microwave power transistors. For information only, RFP not available.

Procurement and Production
R&D Contracts Division
Laurence G. Hanscom Field
Bedford, Mass. 01731

Research in connection with the study of the optical and dynamic properties of dielectric material to be negotiated with Arthur D. Little, Inc., Cambridge, Mass. For information only, RFP not available.

Procurement and Production
R&D Contracts Division
Laurence G. Hanscom Field
Bedford, Mass. 01731

A contract for further research directed to provide materials and technique to evaluate various systems of information retrieval will be negotiated with Arthur D. Little, Inc., Cambridge, Mass. For information only, RFP not available.



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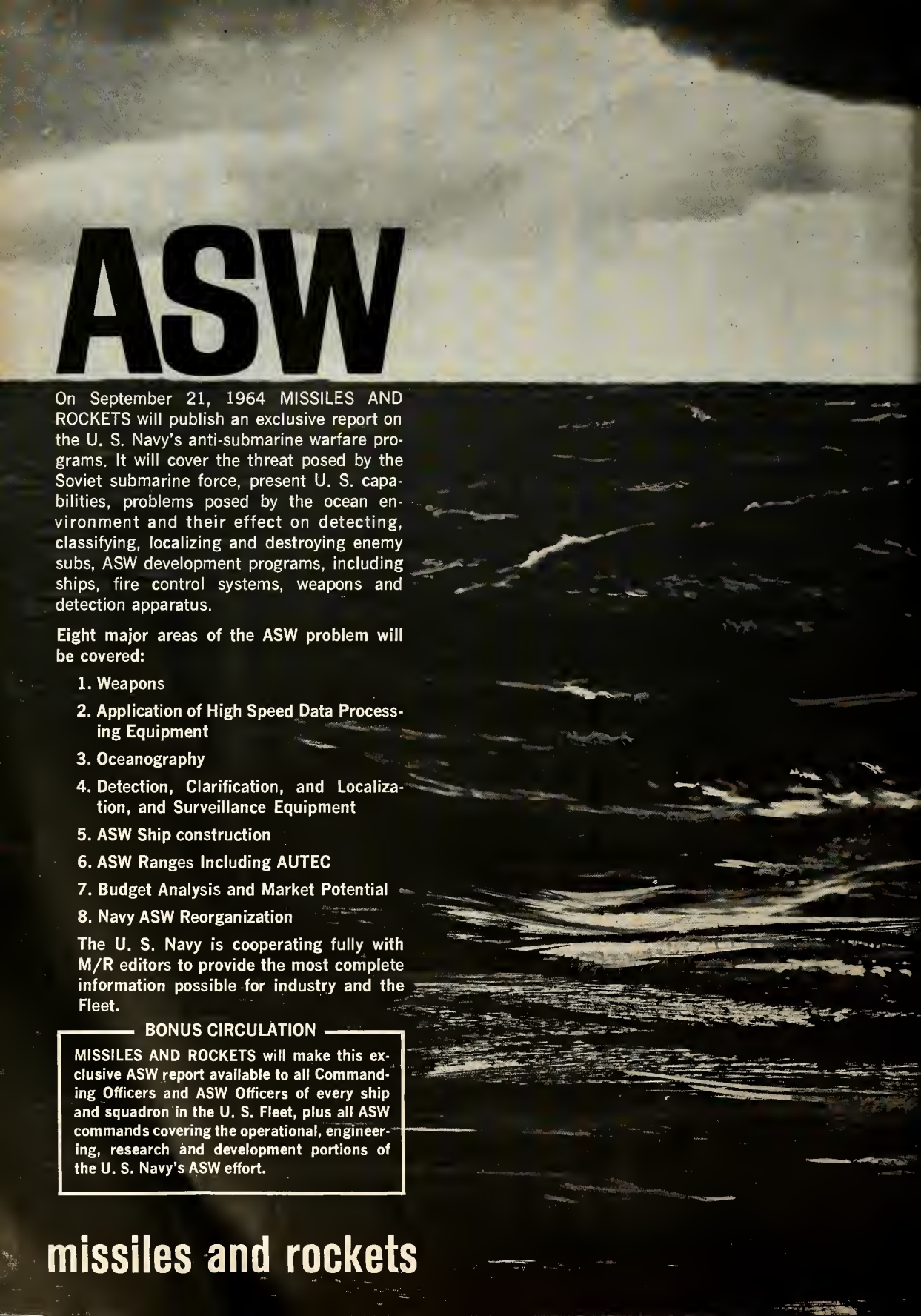
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ASW

On September 21, 1964 MISSILES AND ROCKETS will publish an exclusive report on the U. S. Navy's anti-submarine warfare programs. It will cover the threat posed by the Soviet submarine force, present U. S. capabilities, problems posed by the ocean environment and their effect on detecting, classifying, localizing and destroying enemy subs, ASW development programs, including ships, fire control systems, weapons and detection apparatus.

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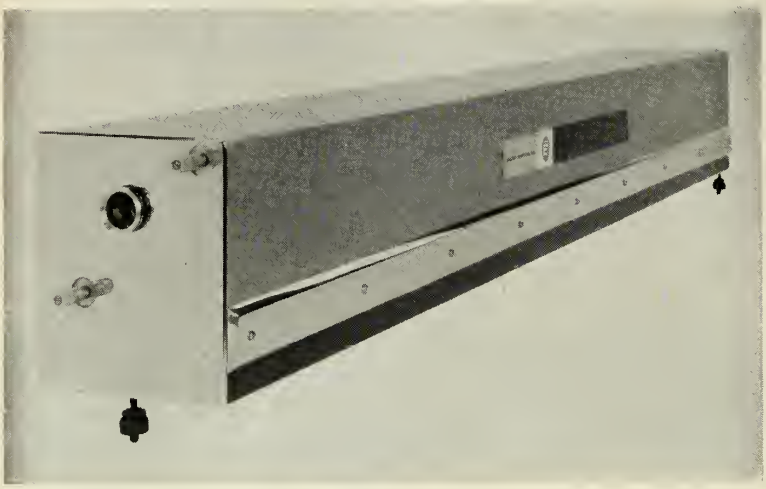
missiles and rockets



Publication Date: September 21, 1964
Closing Date: September 7, 1964

products and processes

Products featured in this section have been selected from those to be displayed at the Aug. 25-28 Western Electronic Show (WESCON) and IEEE Summer Meeting in Los Angeles.



New Product of the Week:

'Universal' Laser

Energy Systems, Inc., has developed a "universal" laser that can produce hundreds of laser lines in the ultraviolet to infrared portion of the spectrum by exchanging system components.

To convert the Series 3000 laser to another wavelength, the operator usually only exchanges the plasma tube and mirrors. In some cases, it is necessary to use the d-c power supply or exchange the modulator unit of the pulser.

The unit can cover much of the spectrum by both CW and pulse operation. Multiple-line and band-spectrum operation is also available. Peak output ranges from 1 to 100 watts in the pulse mode. Repetition rates are from 10 to 10,000 pps; pulse widths range from 10 nanosecs. to 3 μsecs.

Circle No. 151 on Subscriber Service Card

Watercooled Flashtubes

Edgerton, Germeshausen & Grier, Inc., has available the Models FX-74 and FX-75 watercooled xenon flashtubes for laser research, flash photolysis and optical or visual illumination sources.

The FX-74 has a maximum average power input of 0.5 kw with a maximum energy per pulse of 100 joules at 150 μs pulse duration. Arc length is 1.5 in; overall length is 7⅛ in.

The FX-75 has a maximum power input of 1 kw with maximum energy per pulse of 400 joules at 1 μs pulse duration. Arc length is 3 in.; overall length is 8⅝ in.

Circle No. 152 on Subscriber Service Card

Ground Isolation Relay

Jennings Radio Manufacturing Corp. is producing a ground isolation relay with power interrupting capabilities of 64 kw. Current and voltage is limited to 8 amps RMS or 8 kv for dc interruptive use; continuous current ratings are 60 amps RMS (60 cycles or dc), 44 amps (2.5 mc), 25 amps RMS (16 mc).

Peak test voltage rating is 20 kv. Contact resistance is 12 milliohms. Contact capacitance is 0.5 mmfd nominal. The unit measures 2½ x 5 in.

Circle No. 153 on Subscriber Service Card

Mechanical Filter

A 6-kc mechanical filter for AM voice applications is being introduced by Collins Radio Co.'s Components Div. Specifications include a center frequency of 455 kc; 3-db bandwidth—6 kc; 60-db bandwidth—20 kc.

Circle No. 154 on Subscriber Service Card

CRT Package Assembly

A high-resolution CRT package assembly for flying spot scanner or photographic recording has been introduced by Electronic Tube Div. of Sylvania Electric Products, Inc.

The plug-in package for display systems consists of a cathode ray tube, deflection coil, focusing coil, alignment magnets, mu-metal shield and supporting hardware. Typical ratings include an anode voltage of 25,000v dc, anode current of 3.0 a dc and peak heater-cathode voltage of 450v. Focusing coil current is approximately 100 ma; line width is 0.0008 in.

Circle No. 155 on Subscriber Service Card

Temperature Chamber

The Model 5703 precision temperature chamber is being produced by Delta Design, Inc. Specifications include a range of −100° to 600°F; temperature control accuracy is ± 2°F; temperature gradients, 1.5°F per 100°F. Internal test volume is 1.85 cu. ft. Coolant is liquid carbon dioxide.

Circle No. 156 on Subscriber Service Card

Miniature Analog Subsystem

The Model 625 "Min M_x" system, a miniature analog subsystem for low-level data-acquisition application, is available from Redcor Corp. The system incorporates an amplifier, filter and multiplex switch on a single card.

The unit features a differential amplifier with six selectable gain positions, accuracy, linearity, stability ± 0.01% and a multiplex switch that can be operated at dc to 50 kc/s (randomly). Thirty-two channels can be packaged in a box measuring 7 x 19 x 22 in.

Circle No. 157 on Subscriber Service Card

Thermopile Meter

TRG Inc., has available a thermopile meter, a precision transistorized microvoltmeter designed specifically for use with thermopiles having outputs of 100 to 300 mv per joule.

The device is able to read energy



directly in joules, eliminating the task of converting from microvolts to joules. Nine scale ranges cover outputs from 1 millijoule to 300 joules with a meter accuracy of ± 2% of full scale. Input is 4.5 watts.

Circle No. 158 on Subscriber Service Card

Binary A-D Converter

A 13-bit binary a-d converter, the Model 846D, has been introduced by Texas Instruments, Inc.

The instrument operates in sign and absolute value code, making more than 50,000 conversions per second with better than 0.05% accuracy. It offers single-ended or differential input with parallel and serial output. Input impedance exceeds 100 megohms; aperture time is 100 nanoseconds. Standard logic levels for data and control are 0 and ± 6v. Nominal input voltages are selectable from the front panel or remotely, with ranges of 2, 4 and 8 v.

Circle No. 159 on Subscriber Service Card

Digital Voltmeter

Non-Linear Systems, Inc., has introduced the Series 4200 digital voltmeter with a speed said to exceed comparable four-digit instruments.

The device has a speed of 20 measurements per second and ranges of ± 9.999/99.99/999.9v. Input impedance is 10 megohms; accuracy is ± (0.03% of reading + 0.02% of full scale). It will reject a-c common mode noise by at least 100 db at 60 cps.

Circle No. 160 on Subscriber Service Card

Laser System

TRG, Inc., has available the Model 106 laser system, consisting of a laser head (pump lamps and ruby crystal), power supply and pulse-forming network, Q-switch, single-pulse accessory and output reflector mount.

The unit has a non Q-switched nominal output of 50 + joules and a Q-switched output of 200 megawatts (4 joules in a pulse width of 20 nanoseconds).

Circle No. 161 on Subscriber Service Card

RF Power Amplifier

A solid-state power amplifier capable of providing 10 watts of output RF power with an efficiency of 45% has been developed by Leach Corp.

The Model TA-1000 has a frequency range of 216 to 260 mc. Temperature range is −20° to 85°C. The unit provides additional filtering of antenna conducted spurious radiation through use of an active amplifier design. It will withstand vibration of 20 g's to 2,000 cps, shock to 150 g's at 11 ms half sine dwell time and acceleration of 150 g's

Circle No. 162 on Subscriber Service Card

Cathode Ray Tube

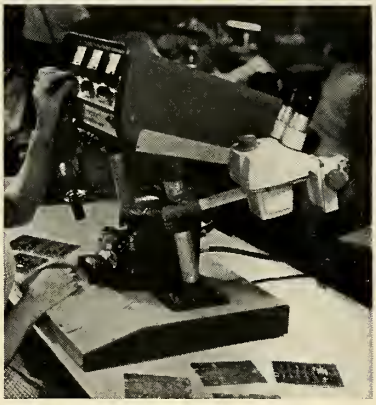
A cathode ray tube with a fiber optics strip inserted in the faceplate designed for high resolution photographic recording has been introduced by Electronic Tube Div. of Sylvania Electric Products, Inc.

The SC-3800 is designed for ground anode voltage circuit applications only. The fiber optics strip has an approximate active area 8.5 in. long by 5/16 in. wide. Maximum anode voltage is 15,000v dc. Focus electrode voltage is 3,300v dc.

Circle No. 163 on Subscriber Service Card

Welding Unit

A dynamically controlled welder, said to deliver seven times the power previously available at the tips, is available from Texas Instruments, Inc.



The Model 705B also features selectable pulse width control. Physical specifications include a stroke of 0.5 in.; clearance, 5/8 in.; gap width adjustable from 0 to 150 mils; maximum electrode step, 50 mils, and tip force, 0 to 8 lbs.

Circle No. 164 on Subscriber Service Card

Servomatic Analyzer

A servomatic analyzer with dc offset for adjustment of the zero level to some desired bias displacement is available from Servo Corp. of America. The unit also features internal modulation to provide faster image with greater memory during low-speed servo analysis.

Waveshapes available for the Model 1995 are sine, triangle, square, modulated sine, modulated triangle and modulated square. Frequency range is 0.005 to 1,000 cps, continuously variable in five ranges. Phase accuracy is ± 2%. It accepts carrier frequencies from 50 to 10 kc.

Circle No. 165 on Subscriber Service Card

Reflex Klystron Amplifier

A reflex klystron amplifier designed to deliver at least 15 milliwatts at 16.5 gc under severe environmental conditions has been developed by Varian Associates.

The fixed-frequency VA-276A has a trimmable range of ± 100 mc for each tube. Beam voltage is 300v dc. Beam current at 300v is 30 ma dc. Maximum weight is 5 oz.

Circle No. 166 on Subscriber Service Card

Electro-Mechanical Chopper

Cambridge Scientific Industries, Inc., is marketing an electro-mechanical chopper 0.4 in. in diameter and weighing 12 grams.

The Model 6027 has a noise level of less than 1 microvolt RMS as measured into a 100 K ohm load. The all-welded unit can withstand vibrations of 10 g's to 2,000 cps. Lifetime is rated at 2,000 hours minimum.

Circle No. 167 on Subscriber Service Card

Chart Recorder

Nesco Instruments Div. of Datapulse, Inc., is marketing the Model 210 transistorized chart recorder. The device features epitaxial planar silicon transistors for low noise and stable operations from 0 to 55°C.

The recorder provides nine ranges from 1 mv to 10v and 0.5% accuracy. Full span response is 0.4 second. It provides positioning of zero any place on the chart or up to ± 50% off chart by panel control. Calibrated chart width is 5 in.

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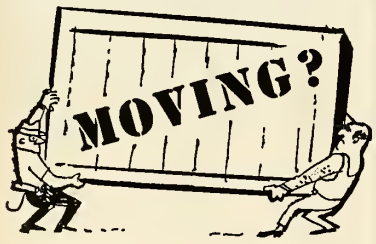
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Fairchild Stratos Corp. elected two Republic Aviation Corp. directors to its board. They are **M. I. Peale,** president of Republic (Farmingdale, N.Y.) and **M. V. Platt,** a Republic director. Fairchild is located in Hagerstown, Md.

Samuel B. Sherwin: Appointed executive assistant to the president of Gulton Industries, Inc., Metuchen, N.J.

Donald C. Prim: Appointed program director of Electronic Programs at the Astronautics div. of General Dynamics Corp., San Diego, Calif. He will direct the division's Glotrac Azusa tracking system, SATAR, and scientific pod programs.

The Board of Directors of Avnet Electronics Corp., New York City, has elected **Lester Avnet** as Chairman (he will also continue as president of the firm); **Morton D. Weiner** as senior vice president; **Anthony R. Hamilton,** a director; and **Myron G. Newberger** as president of Avnet Corp. (West Coast sub.) and a vice president of the corporation.

Bernhard A. Hohmann: Promoted to group director of the new *Gemini* Launch Systems Directorate at Aerospace Corp., El Segundo, Calif.

Brig. Gen. William E. Leonhard (USAF-ret.): Joined the staff of United Technology Center, Sunnyvale, Calif. as assistant director and program manager of the *Titan III-C* solid-propellant booster rocket program. He was formerly chief of staff of the Air Force Systems Command.

Albert Shapero, manager of systems analysis programs at Stanford Research Institute, Menlo Park, Calif., has been named to an advisory panel for the House of Representatives Select Committee on Government Research. He will assist in a study on the impact of federal research and development programs on the nation.

Gustave M. Hauser and **F. Craig Huston:** Elected vice presidents of General Telephone & Electronics International, Inc., New York City. Hauser will be responsible for planning and developing financing for international telecommunications and other projects. Huston will be in charge of telecommunications sales development.

Tex S. Lines: Will head the Management Analysis Dept. of Pan American Airlines' Guided Missile Range Div., Patrick AFB, Fla.

Col. David V. Miller: Has been assigned as program director for the Air Force *Titan III* Standard Space Launch Vehicle System. He is with Air Force Space Systems Div., Los Angeles.

Abraham Hurlich: Appointed manager of a newly established materials and processes section at the Astronautics div. of General Dynamics Corp., San Diego, Calif. He will supervise basic and applied research on materials, materials fabrication processes and evaluation testing of materials and processes.

Leslie F. Nelson: Apponted Chief Engineer of Genisco Data, a division of Genisco Technology Corp., Compton, Calif. Some of his fields of interest are telemetry discriminators and receivers and UHF distribution systems.

Brian Dale: Appointed chief engineer of the semiconductor division of Sylvania Electric Products, Inc., New York City. **J. B. Donner** was also appointed project manager for the *Minuteman* program at the eastern operation of Sylvania.

William W. Smith: Received a Space Act Award from the National Aeronautics and Space Administration for invention and development of a trajectory-correction propulsion system successfully used in guiding the *Mariner* spacecraft to Venus in 1962 and the *Ranger* spacecraft to the Moon in 1964. He is program manager for hydrazine monopropellant control rockets, Rocket Research Corp., Seattle.

Frank Zertler and Perry Joseph: Elected vice-president of The Rauland Corp., wholly-owned cathode ray tube manufacturing subsidiary of Zenith Radio Corp., Chicago.

B. L. Ryle: Appointed vice president, Southern Operations for Mesa Scientific Corp., Inglewood, Calif.

Arthur Asch: Appointed marketing manager of Kawecki Chemical Co., Boyertown, Pa. He was formerly president of Electro-Tec Corp.

Robert F. Haase: Named regional industrial sales specialist for the mid-eastern states by Motorola Semiconductor Products, Inc.

—when and where

AUGUST

Navigation, Guidance and Control Conference, Institute of Navigation, AIAA, and AAS, University of California, Los Angeles, Aug. 24-26.

Western Electronic Show and IEEE Summer General Meeting, Biltmore Hotel, Los Angeles, Aug. 25-28.

Gravity Day, sponsored by the Gravity Research Foundation, New Boston, N.H., Aug. 29.

148th National Meeting, American Chemical Society, Chicago, Aug. 30-Sept. 4.

69th Summer Meeting, American Mathematical Society, Amherst, Mass., Aug. 30-Sept. 4.

Eleventh International Congress of Applied Mechanics, sponsored by the International Council for the Congress of Applied Mechanics, Deutsches Museum, Munich, Germany, Aug. 30-Sept. 5.

Symposium on Approximation of Functions, sponsored by General Motors Research Laboratories, Warren, Mich. Aug. 31-Sept. 2.

Electric Propulsion Conference, AIAA, Bellevue-Stratford Hotel, Philadelphia, Aug. 31-Sept. 2.

45th Summer Meeting, sponsored by the Mathematical Association of America and the American Mathematical Society, Univ. of Massachusetts, Amherst, Aug. 31-Sept. 2.

Third Geneva Conference on the Peaceful Uses of Atomic Energy, sponsored by the United Nations, Geneva, Switzerland, Aug. 31-Sept. 11.

SEPTEMBER

Third Biennial Aerospace Power Systems Conference, AIAA, Bellevue-Stratford Hotel, Philadelphia, Sept. 1-4.

Meeting of the International Commission for Optics, Tokyo and Kyoto, Japan, Sept. 1-8.

Chemistry of Matrices used in Filament Winding Symposium, 148th National Meeting of the American Chemical Society, Sheraton-Chicago Hotel, Chicago, Sept. 3-4.

Symposium on Spacesuits and Human Performance, sponsored by the Society of Engineering Psychologists, American Psychological Association Annual Convention, Biltmore Hotel, Los Angeles, Sept. 6.

International Conference on Magnetism, sponsored by the International Union of Pure and Applied Physics and the British National Committee for Physics, Nottingham, England, Sept. 7-11.

International Conference on Microwaves, Circuit Theory and Information Theory, IECE of Japan/IEEE, Tokyo, Japan, Sept. 7-11.

Fifteenth Congress, International Astronautical Federation, sponsored by the IAF, Warsaw, Poland, Sept. 7-12.

National Power Conference, IEEE and ASME, Mayo Hotel, Tulsa, Okla., Sept. 9-11.

Twelfth Annual Engineering Management Conference, sponsored by the IEEE, ASME, AIIE, ASCE, and others, Pick-Carter Hotel, Cleveland, Sept. 9-11.

Advanced Incentive Contracting, sponsored by the National Defense Education Institute, Boston, Sept. 9-11.

54th National Meeting of the American Institute of Chemical Engineers, Flamingo Hotel, Las Vegas, Sept. 13-16.

Eighth National Convention on Military Electronics, sponsored by the IEEE and the Military, Washington Hilton Hotel, Washington, D.C., Sept. 14-16.

Symposium on Mass Spectrometry sponsored by the Group for the Advancement of Spectrographic Methods, Paris, Sept. 14-18.

World Conference on Radio Meteorology sponsored by the American Meterological Society, National Bureau of Standards, Boulder, Colo., Sept. 14-18.

Techniques of Value Engineering for Defense and Space Contractors, sponsored by the National Defense Education Institute, Washington, D.C., Sept. 14-18.

First International Cellular Plastics Conference sponsored by the Cellular Plastics Div. of the Society of the Plastics Industry, Inc., Barbizon Plaza Hotel, New York City, Sept. 14-18.

"Modern Engineering Applications of Computers," a course sponsored by Control Technology, Inc., Edgewater Inn, Long Beach, Calif., Sept. 14-18.

49th Norelco X-Ray Analytical School sponsored by Philips Electronic Instruments, Sir Francis Drake Hotel, San Francisco, Sept. 14-18.

Third European Symposium on Chemical Reaction Engineering, Amsterdam, Netherlands, Sept. 15-17.

Electronics Division Fall Meeting sponsored by the American Chemical Society, Sheraton Hotel, Philadelphia, Sept. 15-18.

Ceramic-Metal Systems Division Meeting sponsored by the American Chemical Society, French Lick-Sheraton Hotel, French Lick, Ind., Sept. 15-18.

Value Engineering Conference, sponsored by the North Alabama Chapter AIIE, Officer's Club, Redstone Arsenal, Sept. 16.

Annual Engineering Management Conference, sponsored by AIIE, IEEE, ASME, and ASCE, Pick-Carter Hotel, Cleveland, Ohio, Sept. 17-18.

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No Tears, No Sorrow

PRESIDENT JOHNSON soon will begin reviewing his Administration's space planning for the years beyond the *Apollo* lunar-landing mission. Projects which will be under discussion still seem very much in the science-fiction realm at a time when the lunar mission itself has yet to be accomplished.

Talk of large orbital space laboratories, of exploration of Mars and of many other exotic space ventures may seem a little blue-sky at a time when man has yet to set foot on the Moon—but advanced planning for such missions must be considered now due to the long-term nature of such programs.

When one considers how much can be accomplished on the Moon itself in the wake of the initial *Apollo* landings, the serious nature of the post-*Apollo* planning becomes apparent.

The effort to support a painstaking and thorough exploration of the lunar surface will be a major one. In scope, this exploration and the planetary explorations which will follow, will place the *Apollo* project in perspective as the early pioneering effort it is.

It is hard even to realize the import of the manned lunar landing before it takes place. Yet, hardware for *Apollo*—the space vehicles, boosters, command and control facilities, test equipment—is today reality. Close behind it must come the planning for the next space missions.

Little wonder then that the doubters, the men of little imagination and little faith, can send up their shouts of gloom and doom for an industry that is on its way to the stars. How can one picture a lunar settlement as reality when the lunar landing itself is hard to imagine even when staring at the very hardware which will accomplish it?

We are pleased to see, therefore, that after months of deep sorrow for the missile/space industry expressed by some of the nation's general news publications, they are awakening to the fact that things aren't as bad as they thought.

The realization now is seeping through that minor cutbacks cannot be extrapolated into conversion of the nation's most vigorous and spirited industry into manufacturers of aluminum canoes and birth control pills.

It was not difficult to predict that such talk would arise in this year when no spectacular manned shots are on the schedule of the National Aeronautics and Space Administration and when many important projects are under evaluation at the Dept. of Defense.

The extreme publicity which the Administration gave to minor defense cutbacks and to an economy drive which in many ways was a myth from the start only heightened apprehension in many circles.

Only lately have these observers begun to realize what a healthy state this industry actually is in. We can only comment that it is about time.

We can attribute this turn of events—and welcome it is—to the fact that some of our journalistic cousins have decided to take a deeper look at the situation. We will let them speak for themselves—and what they say is important in marking an upswing in industry morale.

The financial page of the Sunday *New York Times* of August 16 puts it this way:

"On the whole, however, the aerospace-defense industry remains not only very healthy but still growing. A succession of recent developments would indicate that the period of growth may well be extended indefinitely. These include the dramatic and successful *Ranger* Moon-shot, the serious turn of events in Southeast Asia and Cyprus, and the injection of the nation's military strength as an issue in the Presidential campaign. All of these have served to bring the aerospace-defense industry back into the public spotlight.

"One result has been to stimulate renewed interest in aerospace stocks in Wall Street. These issues had been depressed in recent months as the whole future of the industry appeared obscured. Now that the focus is clearer, market analysts and investors alike are taking another look. With many industry leaders reporting sharp rises in sales and earnings for the latest fiscal periods, the view is decidedly brighter."

If we may say so, we and that weekly aviation magazine have been saying so all along. It is a relief to find that the period of panic is ending in public recognition that perhaps it wasn't there at all.

The respected financial publication, *Forbes,* has just published a lead editorial by Malcolm S. Forbes which is causing considerable comment in the industry. Entitled "No Tears in the West," it has this to say:

"Defense stocks are depressed, as a glance at their price/earnings ratios makes clear. Along with most other publications, *Forbes* has often discussed the reasons why.

"But on the West Coast, they haven't got the word. I just spent two days talking with some of the ablest tops in the defense-oriented giants and they were actually, positively, and, in most cases, *convincingly* optimistic. Optimistic yet!"

Mr. Forbes talked to industry leaders such as J. L. "Lee" Atwood of North American Aviation, Ruben Mettler of TRW Space Technology Laboratories and others, and he came away convinced: "There were no tears in the West."

YOU CAN JUST BET your bottom stock option, Mr. Forbes, that there are no tears out there. The future of this industry is a bright one. Certainly, there is change ahead and the companies in the industry must be prepared to cope with it. That's exactly what we said on this page last March after talking to the same people.

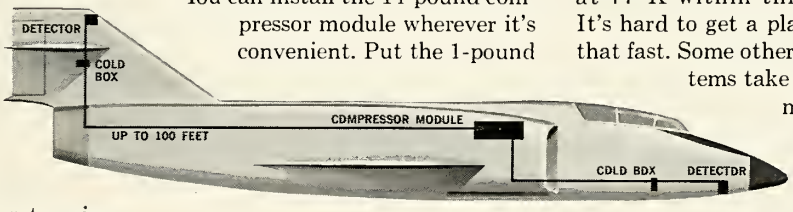
But this industry has grown up on change. There may be a few company casualties but, as an industry, this one knows better than any other in the country how to cope with advancing technology.

We are delighted with the restoration of confidence which is resulting from recognition of the facts.

William J. Coughlin

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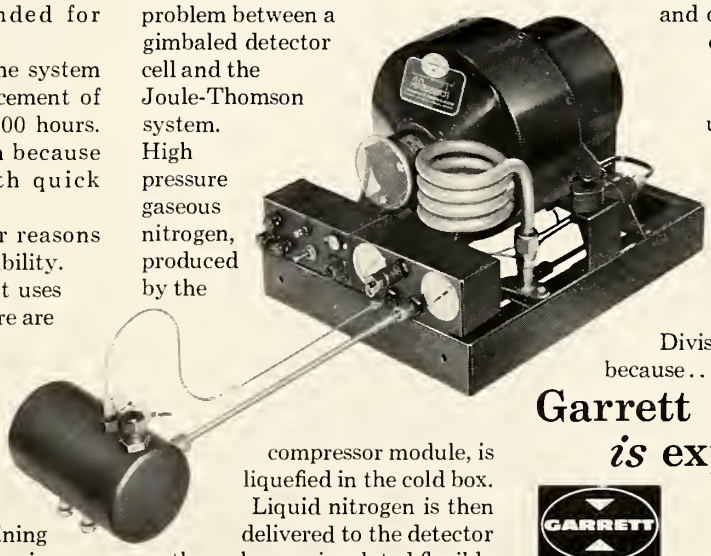


This is the system that will let you forget major maintenance for the life of the average aircraft. Actual test data show that its compressor unit will operate unattended for 2500 hours.

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AUGUST 31, 1964

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



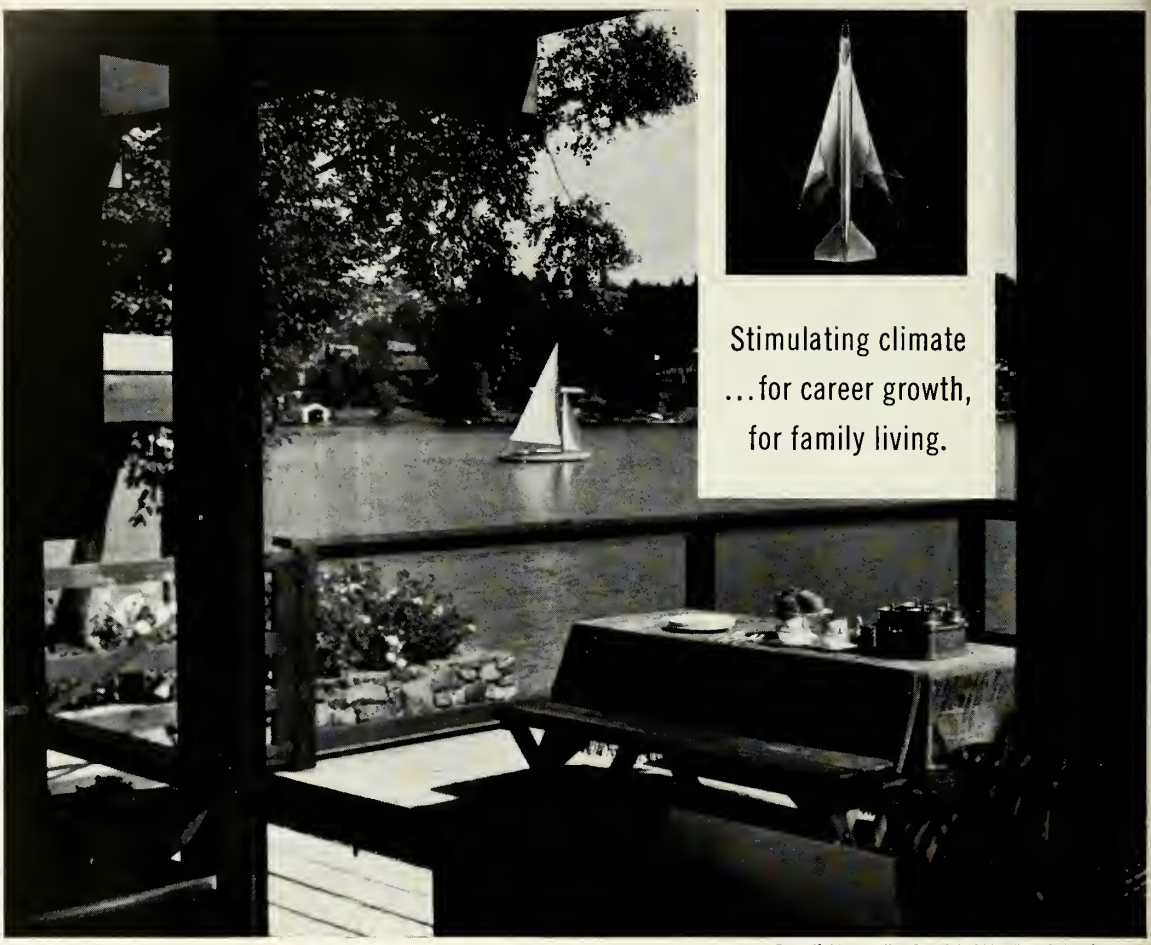
HIBEX Firings Scheduled To Start This Year

Non-Man-Rated Titan III Urged

Report from WESCON

Simulation State of the Art

First Photo of HIBEX Model



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Senior Engineering Openings at Boeing

Boeing, the world leader in advanced swept-wing, multi-jet aircraft, is today pioneering evolutionary advances in both civilian and military aircraft fields. These programs have created outstanding openings for senior engineers in the following fields. A limited number of project design positions are also available.

Structural Dynamics Duties involve analysis and experiments in aeroelastic fields of flutter and dynamic loads. Requirements are a B.S. or advanced degree in applied mechanics with significant aerodynamic and structures background, plus 4 to 8 years of experience related to high-speed aircraft. Should be familiar with latest theories and techniques for analysis and test.

Stability and Control Requires strong background in airplane flight control system design and analysis, and stability and control characteristics, plus knowledge of computers, servomechanism design and development and testing of airplane configurations. Master's degree or equivalent, 5 to 10 years of experience.

Flight Control Systems Assignments involve establishing dynamic design criteria and specifications for flight control systems, sub-systems and components; selection of most suitable control system components, and guidance of control system procurement and flight test. Requires B.S., M.A. or M.S. in engineering, mathematics or physics with 5 to 10 years' applicable experience.

Metallurgy Assignments entail alloy selection and application; development and improvement of processes; preparation of specifications, laboratory experiments, technical consultation, and service failure analysis. Requirements, in addition to 3 to 10 years' experience in aircraft technology or a related field, include familiarity with the electron microprobe and microscope and standard metallurgical equipment.

Mechanical Engineering Responsibilities involve development and improvement of processes through laboratory experiments, preparation of specifications, technical consultation with aircraft designers, vendors and subcontractors, and service failure analysis. Requirement: 3 to 10 years' experience.

Chemical Engineering Openings require 5 to 10 years of experience in lubrication materials and concepts; elastomeric, inorganic finish, and organic polymeric materials, and structural adhesive bonding, plus a basic knowledge of materials behavior. Work involves evaluation, analysis and investigation of all materials characteristics, including mechanical, electrical, chemical and surface.

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Volume 15, Number 9 August 31, 1964

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THE COVER



Model of HIBEX missile is shown for the first time. Test firings of the Boeing experimental vehicle are set to begin by the end of 1964. Hercules Powder Co. is major propulsion contractor for the program, aimed at developing extremely high acceleration missiles. See story, p. 10. (M/R photo)

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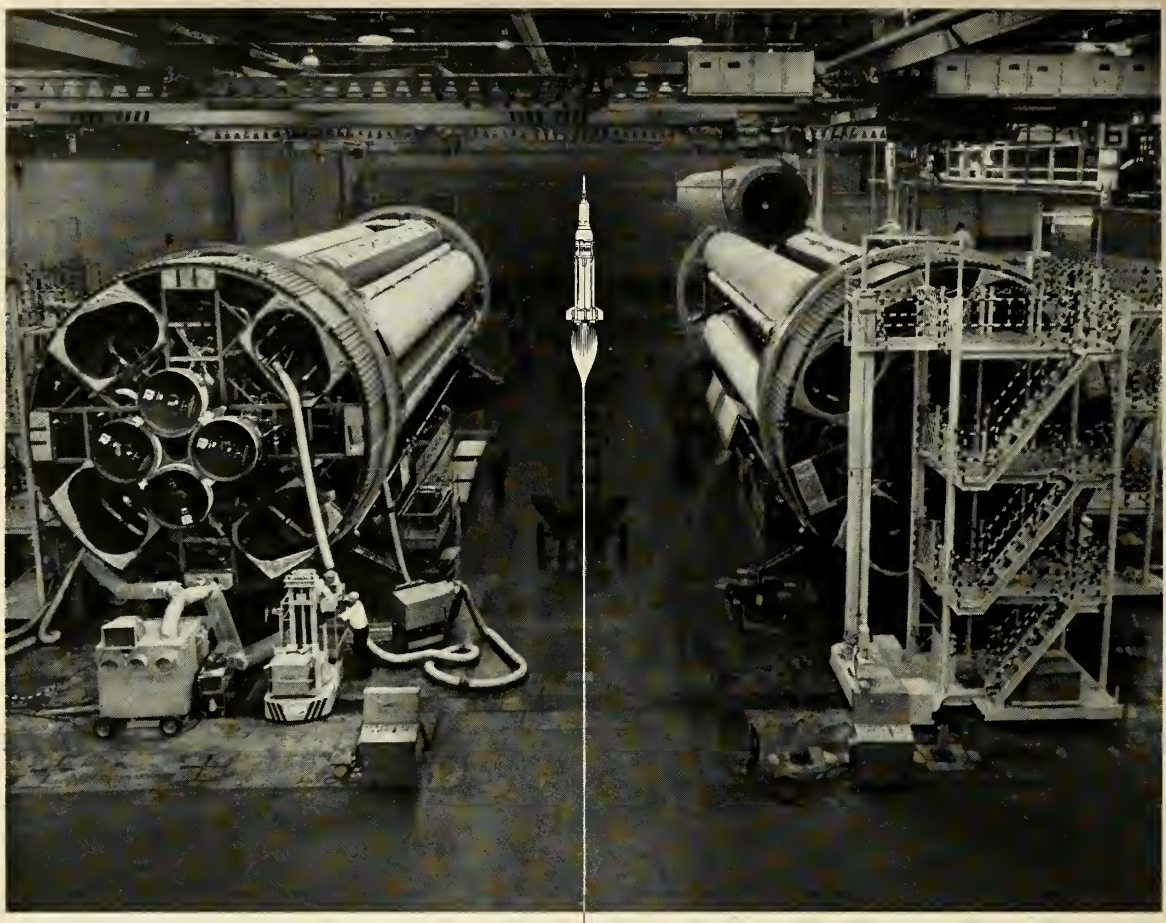
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This is the booster . . . that made the difference . . .

On January 29, a NASA Saturn I just like these boosted a 37,700-pound payload into orbit. It helped change the shape of the space race, putting the U.S. in the lead.

Now CHRYSLER Corporation SPACE Division is moving into high gear on the Saturn IB, successor to the dependable Saturn I. The mission potential of the Saturn IB vehicle is greatly broadened by reducing the weight of the boosters and increasing engine power.

Chrysler's look-ahead team of scientists and engineers is working closely with NASA's George C. Marshall Space Flight Center in developing the full potential of the booster for the Saturn IB vehicle. This developmental work goes on even as final tests are being run on the last Saturn I booster Chrysler will build.

As prime contractor on the Saturn I/IB program, CHRYSLER Corporation SPACE Division has a continuing need for creative, experienced engineers and scientists at all levels and in many disciplines. Some of the challenging positions now open are listed on the page opposite.

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letters

Ranger VII Photos

To the Editor:

Thanks for passing on quickly to us the excellent lunar pictures.

Not being a photographic expert, I am deeply puzzled by two features of the lunar landscape which I would like to see scientifically explained. Number one is the total lack of cracks or fissures. Would not a landscape formed by cooling lava contain such fissures? Would not a hard surface shaken by earthquakes (or rather moonquakes) resulting from volcanos or huge meteors show cracks? Would not the sudden day-to-night temperature changes result in small cracks? Could it be that the ancient, large cracks have filled with dust to the point where they are no longer visible?

The second puzzle is the soft, rounded appearance, even from 35 miles altitude. To me this suggests dust, and deep dust. Have you ever taken rock or shot of various sizes and thrown it into pulverized dust? I hope our scientists are right about it being 1 to 2 inches deep, because I get the impression it may be 1 to 50 feet deep, especially after looking at the sharp edges of the large rock in the deep crater.

T. M. Morse
Santa Maria, Calif.

Most scientists believe that the Moon at one point developed fissures on its surface, but that these were concurrently or subsequently filled by outflow of lava. As for the depth of lunar dust, the small (3 ft. in dia. and 1 ft. deep) craters shown in the final Ranger VII photos would not be visible if the dust layer were more than a few inches deep.—Ed.

To the Editor:

Your account of the *Ranger VII* was very informative; however, after observation of the photos, I noticed that the picture taken at 85 miles shows a time of about 18:20 hours, while the one taken at 34 miles shows about 17:50 hours.

R. H. Botz
Canoga Park, Calif.

The two photos referred to are in proper sequence, as indicated by examining them and the accompanying elapsed-time indicators. NASA says two separate clocks, with different settings, are shown.—Ed.

Hydra-Iris Credit

To the Editor:

In your Missile/Space Encyclopedia (M/R, July 27) you listed the *Hydra-Iris* under U.S. Sounding and Research Rockets.

The U.S. Naval Missile Center (NMC) was the system developer of the *Hydra-Iris,* not the Atlantic Research Corporation. ARC supplied only the *Iris* upper stage. Also, the total weight of the two stages is 1,716 lbs. (less payload) and length is 27 ft., including the standard *Iris* nose cone. The missile will lift 100 lbs. to 200 n. mi. It is launched from a free-floating launcher developed by NMC.

Jay L. Finkelstein
U.S. Naval Missile Center
Pt. Mugu, Calif.

Engineer's Lot

To the Editor:

The Air Force has recently made various attempts to strengthen the position of the graduate engineer in its employ. Memos were circulated urging non-technical employees to stop rendering engineers ineffective, and confidential reports were encouraged.

That these attempts are bound to fail is pretty clear to those familiar with the methods used to sabotage the work of the engineer.

1. *Withholding of Important Reports*

In this method, the simplest of all, a report that reflects unfavorably on the work done before the engineer was hired is simply destroyed.

2. *The New Department*

The engineer finds himself, suddenly, reporting to a whole new department. Communication that has been directed to him previously is now rerouted through the new department. Usually it consists of four or five people who now "check" his work. Since none of them are technically trained, he has to explain all his recommendations or points in patience-trying sessions. Then they screen his work for items that might prove injurious to them from their failures in the past. His reports are then translated into the usual fractured English, and soon are useless.

3. *Outright Harassment*

Annoying and derogatory notes are sent to his superior, urging greater supervision of his work. By having to defend himself constantly against some attack, he is prevented from attending to the important aspects of his work.

4. *Isolation*

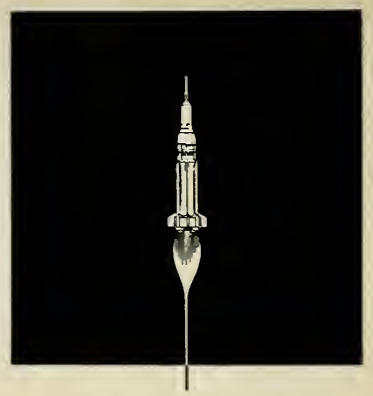
A room, far away from the majority of offices, is assigned to him. He is barred from meetings, and if he wants a report typed has to walk up and down labyrinthian corridors only to find out that no one has been assigned to do his typing.

5. *The Overload*

This is a very successful method. The engineer is simply inundated with material to read and report on. The variety of subject matter would require an encyclopedic store of knowledge or ten assistants. This method invariably offers opportunity for comments like: "We thought that as an engineer, you were supposed to know all about it."

After this sort of treatment many engineers are ready to resign, others throw in the sponge and report only those things acceptable.

Henry Albert
Burbank, Calif.



These positions will be filled immediately in our New Orleans operations

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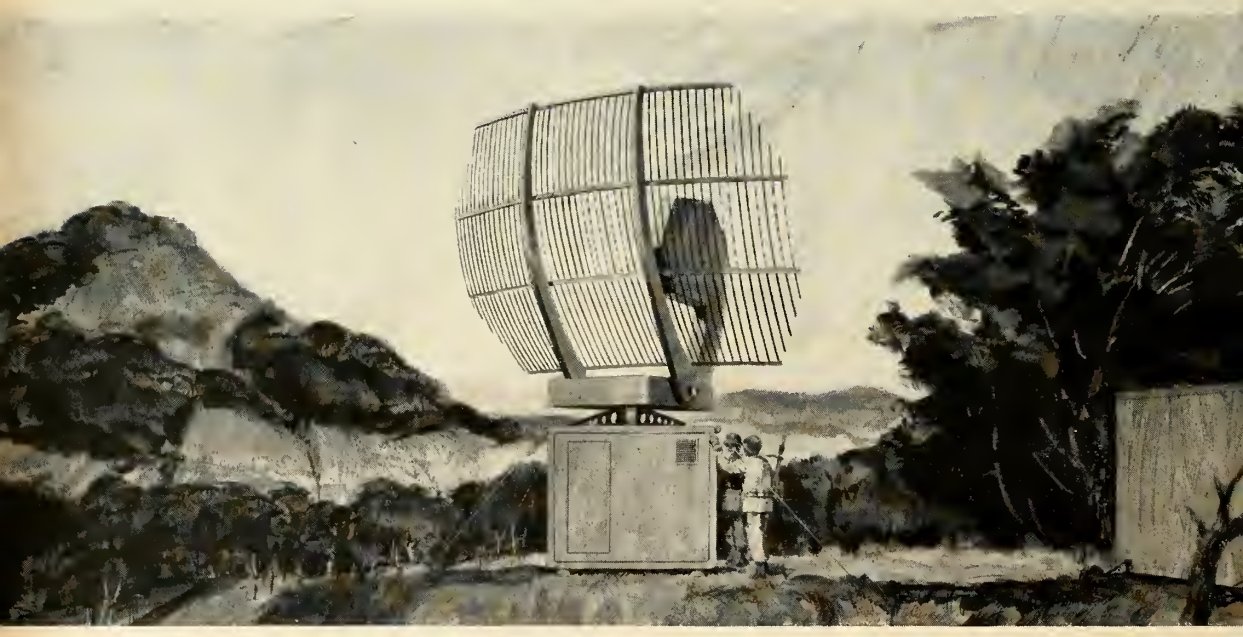
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The Countdown

WASHINGTON

Minuteman Motors Set Off Flap

When it was first learned in Washington that third-stage motors for the Wing VI *Minuteman* had been called back to Hercules Powder Co. from the Boeing assembly plant, Sen. Barry Goldwater said he understood the Air Force was "either going to have to modify the missile or enlarge the holes." Air Force officials retorted that the problem was a minor fix which involved only six motors.

Figures Never Lie, But . . .

Dept. of Defense cost calculation on the interim military comsat system is revealing. Price of the 24-satellite system is placed at $20 million. This does not include the cost—pro-rata or otherwise—of the *Titan III* launch vehicle, integration and checkout of the payload or the launch services involved. It covers little more than the cost of the satellites. In programs not so favored by DOD, all costs associated with the program would be included.

New Life Seen for XLR-11 Engine

NASA is expected to select Thiokol Chemical Corp.'s man-rated throttleable XLR-11 rocket engine as the power-plant for the M-1 and HL-10 lifting body vehicles, which will be used for low-speed flights to study landing characteristics. Big factor in taking the 6,000-lb.-thrust engine out of retirement: it is an inexpensive off-the-shelf item. The XLR-11 first was used in the *X-1* experimental aircraft, last in the *X-15*. No decision is expected until Northrop's Norair Division completes modification of the two vehicles for a power system.

Drifting and Dreaming

NASA officials now estimate that *Syncom III* will reach its stationary orbit over the intersection of the International Date Line and the Equator on Sept. 2. Last week, the spacecraft was drifting at seven degrees per day toward the East, with about 50 degrees still to cover to its post. Hydrogen-peroxide jets will be used to stop the Olympic-relay satellite over its mid-Pacific station.

An Earth-shaking Sidelight on History

Army has awarded a citation to a *Nike-Hercules* battery in Alaska for its outstanding performance during the Alaskan earthquake. The battery was cited for its round-the-clock efforts from the time the quake hit on March 27 until the unit became operational again on April 4—a week later. Interestingly enough, defense officials denied at the time that any missiles were out of commission as a result of the earthquake.

Scale Silo Used in Effects Testing

Air Force interest in vulnerability of its *Minuteman* ICBM silos to ground effects from an exploding nuclear warhead continues. Kirtland AFB engineers will use a novel method of simulation this fall in an effort to get at the problem. Air Force Weapons Laboratory personnel will fill a plastic bag with a measured amount of hydrogen and oxygen, place it in an earth-floor tank and cover the bag with water. By detonating the gas mixture, a nuclear blast wave shock can be simulated and its effect on a quarter-scale *Minuteman* silo studied.

SRAM Missile Gets Tentative Go-Ahead

Defense Research and Engineering officials have given a tentative go-ahead to the *AGM-X-1 (SRAM)* short-range attack missile program. Air Force expects to issue requests for proposals about the first of next year. Missile, similar to *Bullpup*, is expected to have considerably more range.

DOD Sets Terms on Standardized Guidance

Dept. of Defense has laid down an ultimatum to the Air Force on development of a standardized space guidance system (SSGS). DOD will approve funding of SSGS through the hardware development stage only if AF commits itself wholly to the system. As Col. Robert R. Duffy, military assistant for plans and policy in DDR&E puts it, "Air Force has got to be willing to have its future space systems designed around the capability that a standardized guidance system would provide." In other words, if you get it, you're stuck with it. AF, meanwhile, is evaluating results of SSGS phase I studies undertaken by industry. No formal proposal has been made to DOD.

INDUSTRY

Fairchild Stockholders To Vote on Name

Fairchild Stratos Corp. stockholders will vote at a special meeting Sept. 21 on changing the name of the firm to Fairchild Hiller Corp. Proposal was made some weeks ago after acquisition of Hiller by Fairchild. Action does not affect Fairchild's new interest in Republic Aviation. Fairchild is continuing to increase its already substantial holdings in that company.

Phillips Named to ERC Post

Franklyn Phillips, formerly director of NASA's Northeastern Operations Office, will be named to fill the position of Asst. Director for Administrative Operations at the new Electronics Research Center. Phillips served earlier as executive officer to Administrator James E. Webb.

Sylvania To Build ICBM Security System

Sylvania Electric Products has been awarded a $1.2-million contract for production of electronic security systems to guard *Atlas* and *Titan* ICBM sites. System lays down a blanket of radio signals throughout the protect area. If these are disturbed, signal change sounds an alarm. Rome Air Materiel Area, Griffiss AFB, N.Y., is administering the contract.

INTERNATIONAL

Nine Nations Sign Comsat Pact

Formal signing of the two communications satellite agreements took place in Washington on Aug. 20. Nine nations—Australia, Canada, Denmark, France, Italy, Japan, Spain, the United Kingdom and United States, plus Vatican City—inked the agreement. Among countries expected to sign later are Belgium, West Germany, Ireland, Netherlands and Switzerland.

First ELDO Launch Vehicle Assembled

All three stages of the projected European Launcher Development Organization's launching vehicle have been assembled for the first time at Britain's Hatfield test site. *Europa I* has a *Blue Streak* as its first stage, with a French second stage and West German third stage. Plans for the vehicle call for launch of an Italian satellite by 1966.

New Bomber Proposal Denied

The Dept. of Defense has denied a published report that the Air Force has submitted to it a proposal for a follow-on manned bomber, but many observers think the craft may turn out to be primarily a missile-carrying aircraft of conventional design.

The plane now envisioned might be only slightly supersonic in long-range flight, but equipped with variable-geometry wings enabling it to achieve higher speed near the target area. It would have considerably greater armament than present bombers and would carry large numbers of small rockets with ranges up to 60 mi.

There has been considerable speculation that the planes will be highly sophisticated spotters for ground-launched missile systems rather than for delivering weapons themselves (M/R, Jul. 27, p. 33, Aug. 3, p. 11).

ERC Gets Cambridge Home

NASA has announced that the Electronics Research Center will be located in Cambridge, Mass.

The site is a 29-acre area near Kendall Square bounded by Binney, Broadway, and Third Streets and the Grand Junction Railroad. A 400-acre satellite site will be selected later somewhere around Route 128 for electronics work that requires an area free of radio frequency interference.

Administrator James E. Webb told Cambridge Mayor Edward A. Crane that several matters must be settled before the ERC can be built. These include getting necessary formal approval by the city from local and federal officials to permit the land to be cleared under Federal Urban Renewal procedures, and the closing down of certain streets. None is expected to be an insurmountable problem.

Shots of the Week

The Soviet Union on Aug. 22 launched *Cosmos* satellites *41, 42* and *43* aboard two vehicles. The launches brought to six the total number of *Cosmos* scientific satellites orbited in less than a week. Numbers *38, 39* and *40* were lofted aboard a single booster Aug. 18 (M/R, Aug. 24, p. 10).

- The Navy successfully fired a *Polaris A-3* from the submarine Tecumseh submerged near the Florida coast Aug. 20. Firing was training exercise conducted by the ship's "gold crew."
- NASA used a four-stage *Scout* rocket to put a 97-lb. *Explorer XX* topside sounder satellite into near-polar orbit with perigee of 540 mi. and apogee of 625 mi. Aug. 25 from Vandenberg AFB, Calif. The satellite is to collect and transmit information on the structure of the ionosphere.
- NASA launched a 200-ft.-dia. balloon from Moberly, Mo., Aug. 26 to study cosmic rays.

Democrats Stress Space

The 1964 Democratic party platform, asserting the nation's strength across the wide spectrum of warfare and its growing pre-eminence in space, calls for more of the same in the next four years.

In space, the Democrats would continue the U.S. drive for space supremacy and encourage greater participation by industry in space research.

"We have created a balanced, versatile, powerful defense establishment capable of countering aggression across the entire spectrum of conflict, from nuclear confrontation to guerilla subversion," the document claims. Promising continued arms superiority, the platform calls the Defense research and development effort "the world's largest."

Among its promises, the platform states that the Democrats, if returned to office, will "maintain our cost-reduction program, to ensure a dollar's worth of defense for every dollar spent, and minimize the disruptive effects of changes in defense spending."

Firms Get NASA Pacts

NASA has selected Rocketdyne Div. of North American Aviation, Inc., and RCA's Aerospace Systems Div. for two new contracts in its manned spaceflight program.

Negotiations are currently underway with Rocketdyne, the space agency announced, to provide 102 more J-2 engines at a cost estimated at $165 million.

RCA was named by the Marshall Space Flight Center to provide 19 more RCA 110A computers for use in the *Saturn IB* and *Saturn V* programs. The firm also has a previous contract to deliver seven of the computers, which will be used to check out, static test and launch the boosters.

The new order for the J-2 engines brings the total number of the engines in the *Saturn IB* and *Saturn V* programs to 157.

According to NASA, 75 will be used in 15 *Saturn V* S-II stages and 15 in *Saturn V* S-IVB stages. In addition, 12 will be used in the *Saturn IB* second stages.

Fourteen will be used as spares for the various stages with the remaining 41 to be used in the launch vehicle and engine test programs.

MMRBM Has Quiet Funeral

Without actually cancelling the *Mobile Medium Range Ballistic Missile* program, the Air Force has dashed any hope for its development.

Secretary of the Air Force Eugene M. Zuckert has had prepared for his signature letters to the major *MMRBM* contractors informing them of the Defense Department's decision not to renew the contracts for work on the program. By this means, DOD has avoided the onus of having "cancelled" the program. The contracts are just being allowed to lapse.

Only one contractor is likely to escape the cancellation—General Precision, Inc., which is developing the stellar inertial guidance system. Defense officials feel that this system is applicable to other missile developments and to the precision orbit and recovery system under development by the Air Force.

The stellar inertial system is to be flight tested this year on the *Polaris A-1*. Three flights are planned. While cutting the budget request from $110 million to $40 million, Congress made clear its intent that the stellar inertial guidance system was the only part of the program to be funded.

Blame for the "cancellation" of the program rests solely with the Defense Dept., according to informed sources. In presenting the *MMRBM* concept to Congress, Secretary of Defense Robert S. McNamara and Defense Research and Engineering Director Harold Brown could offer no more than "a visceral feeling" that the system might be useful if developed.

Without a requirement for the

system, Congress was unwilling to appropriate the estimated $700 million *MMRBM* development cost. As with *LASV*, however, DOD is likely to try to shift the blame for the cancellation to Congress for failing to appropriate the money for a development program.

Contractors for the *MMRBM* in addition to GPI, included: Hughes Aircraft Co., integration assembly and checkout; Philco Aeroneutronic, Fairchild Stratos and Sperry Rand, re-entry system; Hughes, Bunker-Ramo and Sylvania, command and control; Goodyear Aerospace, transporter-erector-launcher; and Thiokol Chemical Co., Propulsion.

'Cleo' Threatens Cape

Air Force officials decided the middle of last week to leave the *Titan III-A* on the launch pad at Cape Kennedy despite the threat posed to it by Hurricane Cleo, but it was not clear if the storm would postpone the vehicle's planned launch Aug. 28.

Four other vehicles also in advanced stages of preparation for launch at the Cape were also affected by the storm. The *Atlas-ABRES* combination was taken down, the *Centaur* stage was removed from an *Atlas-Centaur*, and the *Titan-Gemini* was placed on standby. *Saturn SA-7*, because of its large size, had to be left on the pad.

A successful static firing of the new *Titan III* booster Aug. 21 had prompted the early launch schedule.

The first stage was given a 10-second run to provide a test of the vehicle's basic propulsion system, the Cape's recently modified Complex 20, and the launch crews.

A complete 195-minute countdown was run on the three-stage booster, which was fully assembled and on the launch stand during the firing. Engines were gimballed one degree as they will be during actual flight.

The *Titan III-A*, which will serve as the core of *Titan III-C*, stands 124 ft. tall with all subsystems mated. Addition of solid-propellant strap-on first-stage boosters will make *Titan III-C* as much as 150 ft. tall.

The core consists of the first and second stages normally used on *Titan II* plus a 15-ft.-tall transtage, which will produce 16,000 pounds of thrust. All three stages burn a hypergolic mixture of unsymmetrical dimethyl hydrazine, hydrazine and nitrogen tetroxide.

The first complete *Titan III-C* is due to be flight tested in mid-1965.

ELECTRONIC ENGINEERS

NOW FORMING:

A NEW SYSTEMS MANAGEMENT GROUP

in advanced range technology

This new hand-picked group of senior technical managers will perform an important function for Pan Am's Guided Missiles Range Division at Cape Kennedy. Its members will have responsibility for the development, acquisition, and operational capacity of major range instrumentation systems at the Eastern Test Range.

Project management assignments are currently open on the following systems: MISTRAM, GLOTRAC, MIPIR, Telemetry, Real-Time Computer Center, Range Instrumentation Control System, and ARIS ships.

Reporting to the Division Manager, this staff management group will be responsible for planning, organizing, directing and coordinating the collective efforts of functional technical groups, and acting as GMRD advisor to system contractors. The goal: to provide more effective range support by meeting system performance specifications, controlling costs, meeting schedules, and obtaining maximum usable data during test operations for the life of the system.

These new systems must be ready to support the nation's coming space and missile programs, such as: GEMINI ... MOL ... GEMINI B ... APOLLO ... ASSET ... and TITAN III.

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HIBEX Tests Begin This Year

by James Trainor

HIBEX FIRINGS at White Sands Missile Range, N.M. will begin by the end of this calendar year and will be completed by mid-1965. Ten launches of the proof-of-principle *HIgh-g Boost EXperiment* are planned but this number is "somewhat a function of success," a Defense Department official has told MISSILES AND ROCKETS.

Details of the high-energy experimental vehicle were also revealed for the first time. *HIBEX* is all one stage and is shaped to look more like a re-entry body than the conventional conception of a missile. At first glance, the missile looks like a right circular cone. On closer examination, however, it can be seen that the vehicle is made up of three conical sections of slightly different radii—stacked one atop the other.

The topmost section would contain the payload. In the *HIBEX* program, however, this is just a fairing for aerodynamic streamlining. The center section contains the propulsion unit, and the bottom section houses the single nozzle and control elements. Length of the vehicle is roughly 20 ft.

Boeing is contractor for the *HIBEX* vehicle. Hercules Powder Co. is the major propulsion contractor, with Aerojet-General Corp. the backup propulsion supplier. The Army Missile Command is managing the program for the Advanced Research Projects Agency.

● **Flight control**—Control of the vehicle is maintained by a fluid-injection thrust vector control system. Since the field of fire of a *HIBEX*-type interceptor would have to be 360 degrees, the thrust vector control system must be able to control not only the elevation of the missile but also the azimuth. Therefore, the amount of the fluid injected into the propellant exhaust stream determines the elevation while the location around the nozzle's circumference of the fluid injection determines the missile azimuth.

The high acceleration of the *HIBEX* vehicle poses serious problems of missile and propellant structural strength and vehicle control and it is to the solution of these aspects of a high acceleration interceptor that the ARPA program is aimed, Basically, the objectives of *HIBEX* are:

—To prove the feasibility and performance of high-burning-rate propellants and the ability to guide and control a high-acceleration missile during burn.

—To institute turning maneuvers over wide angles to demonstrate the structural integrity of both the vehicle and the propellant.

—To prove the feasibility of igniting, burning and launching from an underground, hardened silo.

—To demonstrate an ability to point the vehicle in both azimuth and elevation.

● **Strictly experimental**—Defense officials stress that *HIBEX* is strictly an experimental program and not an interceptor. Contracts have been let to Hughes Aircraft Co., Boeing Co. and Douglas Aircraft Co. to study high-acceleration interceptors. These studies should be completed by the end of this calendar year or early next year.

Based on these three studies, the *HIBEX* program itself and various ancillary studies of hard-point defense electronic systems, ARPA is expected to be in a position by the fall of 1965 to evaluate the feasibility and cost of a hard-point defense system.

One of the major problems is the launch from an underground silo. Unlike the *Sprint,* which will be "popped" out of its silo before the motor ignites, the *HIBEX* must burn within the silo. This is to save time, since the lower intercept altitude envisioned in a hard-point defensive system means that time must be measured in fractions of seconds. Although *Sprint* is billed as a high-acceleration interceptor for the *Nike-X* anti-missile missile system, its time scale is much longer than that of *HIBEX*. In fact, according to a Defense official, although *Sprint* is an "appreciable advance over *Zeus,* it still leaves something to be desired."

ARPA is building an underground silo at White Sands for the *HIBEX* test program. Although the silo for a hard-point defensive system would have to be harder than the target it is defending, the *HIBEX* silo will not be so constructed since this is an experimental program into high-energy propellants and not a development program.

● **Status report**—Commenting on the status of the $16-million program, the official said that "as of now, it looks like we are pretty much on the track." There have been no full-scale motor tests yet—the first is scheduled for this fall—but test samples that have been fired "look good." Goal of the program is to provide a propellant with a high burning rate which, in turn, will furnish missile accelerations of more than 800g.

HIBEX trades speed for acceleration with a burn-out velocity slightly lower than that of *Sprint.* In doing so, it pays a premium in the structural strength required of both propellant and vehicle. There is also a very sensitive coupling, or trade-off, between the specific impulse that is desired and the overall weight of the vehicle. Higher chamber pressures are also a consequence of the trade of acceleration for speed.

On the positive side, the velocity/acceleration trade-off results in a smaller and lighter interceptor than a *Sprint*-type vehicle. And, since size and cost are handmaidens in anti-missile missiles, the smaller vehicle would also be cheaper.

There is a possibility, then, that if *HIBEX* technology does prove itself, the higher acceleration missile could be included in the *Nike-X* missile mix—and maybe even supplant one of the slower vehicles.

HIBEX grew out of an examination by ARPA of the problems of a hard-point defense system (M/R, Dec. 24, 1962, p. 14). This study which began about three years ago, examined the problems of defending hard targets such as *Minuteman* silos and command and control facilities to see if the problems were sufficiently different from an area (or city) defense to warrant a separate effort. The conclusion was that such a system differed radically from the *Nike-Zeus, Nike-X* type.

In the simplest of terms, since the area to be defended is smaller, and many times harder than a city, the altitude of interception can be much lower. The re-entry bodies have by then been stripped of their decoys by the atmosphere and the warheads themselves have been channeled into a relatively small cone of entry (threat corridor). This allows the use of lower power, less agile radars, and, since the radar is the dominating cost of an anti-missile system, a hard-point defense system is cheaper than a comparable area defense system. ■

To replace Atlas-Agena D . . .

AF, Martin Recommend Development of Titan III Non-Man-Rated Version

TITAN III-X—a non-man-rated version of the *Titan III-A*—is under study by the Air Force as an economical space launch vehicle for unmanned payloads in the latter part of this decade. Space Systems Division of the Air Force Systems Command and the Martin Co. have completed studies of such a vehicle, and have recommended its development.

Basically, the *Titan III-X* would eliminate those systems and structural modifications required for man-rating the standardized space booster—including the malfunction detection system (MDS). The stringent reliability requirements for a man-rated booster and the MDS system add to the expense of the space booster and reduce substantially its cost/effectiveness for unmanned missions.

A launch vehicle that would eliminate these costly systems, therefore, was the goal of the *Titan III-X* study. So far the program has not progressed beyond the study phase, but AF officials are optimistic that it will. Once production of *Atlas* is ended, there will be a requirement for a cost/effective launch vehicle for unmanned space programs. The Air Force feels that *Titan III-X*, in combination with *Centaur* or a high-energy liquid fluorine stage, would satisfy this requirement.

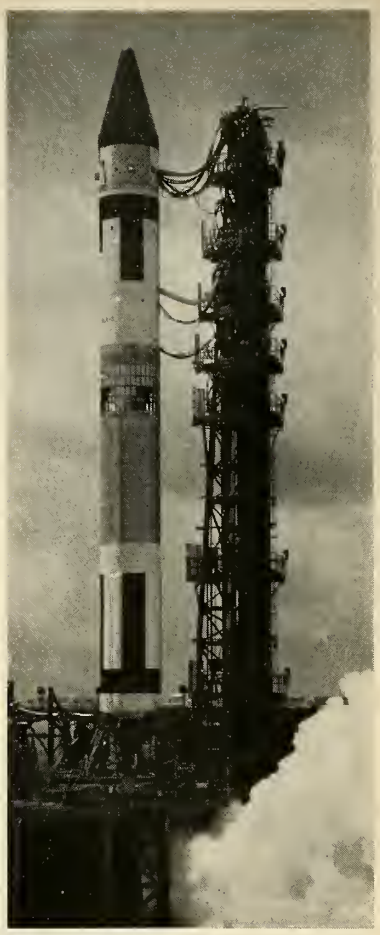
Since NASA officials have determined that it is not economically feasible to refurbish *Atlas* ICBM's retired from the strategic inventory as space boosters, they admit that, if the Air Force developed such a vehicle, NASA would have to use it.

Titan III-X would fill the role presently assigned to the *Atlas-Agena D*, would orbit payloads in the 3,000-6,000-lb. category and, with *Centaur* or a fluorine upper stage, would be able to take several thousand pounds to escape velocity.

Titan III-A consists of a liquid, storable-propellant *Titan II* which has been structurally modified to accept the Transtage, the control module and the payload. *Titan II* ICBM's without similar structural modifications could not be used for the *Titan III-X*, according to Air Force officials.

At present, other than being designated as the launch vehicle for *Gemini B* and the *Manned Orbiting Laboratory*, most of the missions for *Titan III* involve unmanned payloads. The R&D flights are carrying, in addition to flight instrumentation, five different communications experiments, several scientific payloads and an interim communications satellite system.

Although detailed consideration of the full *Titan III* with the solid strap-on motors was an adjunct to the *Titan III-X* study, there is no reason why a non-man-rated version of this launch vehicle could not be used. However, this is controversial, since it involves trade-offs and cost/effectiveness analyses with the similar capability of the *Saturn IB*. ■



FIRST-STAGE of first Titan III-A static-tested at Cape Kennedy Aug. 21 (see p. 9).

New 156-in. Solid Program Imminent

REQUESTS FOR PROPOSALS will be issued by the Air Force early in September on a four-package, $12-million follow-on program to the current 156-in.-dia. large-solid demonstration effort.

Competitive bidding on a fixed-price incentive basis will be the rule. Firms will be able to bid on any one or more of the packages. Four distinct motors will be involved. The Air Force apparently intends to have these motors designed as close as possible to future military applications.

Two of the motors will be 156-in.-dia.; the others will have smaller diameters and be aimed at upper-stage use. One major difference from the earlier 156-in. program will be a planned decrease in the 120-sec. burning time.

Packages will fall somewhere between future ICBM applications and a space booster with near-instant readiness. Industry experts indicate the program will more closely resemble the ICBM application. The large first stage in the program will be segmented.

As in the first demonstration program, no advance propellant technology will be involved. The program is reoriented to the extent that it is not a move into a direct follow-on program.

Air Force officials stress that any future work on the 260-in. solid program will be conducted solely by NASA. Funding and management of the program has been split between the two agencies in the past, but the AF sees little military application for the 260 and insists that NASA must manage any future work in this area.

OGO-A To Carry 20 Experiments

First of six to be NASA's heaviest scientific satellite to date; will probe for manned spaceflight hazards caused by Sun

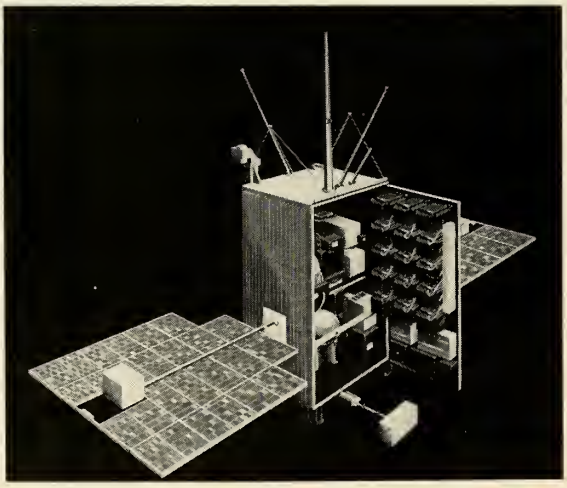
by Hal Taylor

THE SPACE AGENCY will attempt early next month to launch its heaviest scientific satellite—the *Orbiting Geophysical Observatory*.

Designated *OGO-A*, the 1,073-lb. spacecraft will also carry more scientific experiments (20) than any satellite ever launched by the U.S.

The flight is scheduled for no earlier than Sept. 3 from Cape Kennedy. An *Atlas-Agena* launch vehicle will boost it into an elliptical Earth orbit with a perigee of about 170 mi. and an apogee of 92,000 mi. The period of each orbit will be approximately 63 hours.

OGO-A far outweighs any other NASA scientific satellite ever put into orbit. While the *Saturn I* booster has put a 37,700-lb. *Apollo* boilerplate spacecraft payload into space, it did not carry scientific experiments.



NASA'S Orbiting Geophysical Observatory (OGO) spacecraft with experiments mounted on the access door of the main body.

• **Goals of series**—The overall scientific objective of the *OGO* series—five more will be launched—is a better understanding of the physical processes relating to the Sun's influence on the near-Earth environment and an evaluation of the possible hazards to manned space flights.

In galactic space, its scientific experiments will study such things as cosmic rays, radio astronomy and the Gegenschein, which is a faint glowing area in space emanating from a direction opposite the Sun.

Measurements in planetary space will include the composition of the neutral atmosphere, density and temperature of the ionosphere, micrometeorites, magnetic fields, geomagnetically trapped radiation, and very-low-frequency emissions. In interplanetary space, data will be obtained on energetic solar protons, solar wind, magnetic fields, solar X-rays, ultraviolet radiation and micrometeorites. Other satellites in the series will make similar studies, but from widely different orbits.

Thus far the *OGO* program has cost some $120 million. With a space agency estimate that future costs will hit $90 million, the total pricetag for the program will reach $210 million.

The *OGO* satellite was developed for NASA by the TRW Space Technology Laboratories under the overall management of the Goddard Space Flight Center.

• **OGO-A details**—The space agency describes the satellite as looking "like an insect." The description stems from the fact that booms, antennas, attitude-control jets and solar panels extend in various directions from its rectangular box-shaped body.

With its various appendages extended, the *OGO-A* is 59 ft. long and 50 ft. wide. It contains more than 100,000 parts.

Other major engineering features include:

—An active three-axis, five-degree-of-freedom attitude-control system that will point the bottom portion of the main body always toward the Earth, the solar panels automatically toward the Sun, and rotate the experiment packages in the direction of motion.

—An advanced thermal control subsystem featuring several types of controls. For example, three sides of the main body are insulated with multiple layers of aluminized Mylar. The other three sides, which will never face the Sun, include a series of louvers that will automatically open and close to maintain a main body interior temperature range of from 41° to 95°F.

—Its communications system will be the most advanced ever incorporated into a satellite. It will be able to handle 254 different ground-originated commands and a data-handling system that will store up to 86 million bits of data on tape recorders, and can transmit to ground stations in real time at a rate of 64,000 bits per second.

• **Future observatories**—Future satellites in the series will be able to carry up to 50 experiments on each flight. The second spacecraft in the series—*OGO-B*—is scheduled for launch next year. It will be placed into a near polar orbit from the Air Force Western Test Range by a *Thrust-Augmented-Thor Agena*.

Also carrying 20 experiments, it will serve primarily as an atmosphere observatory. ■

BSD Chief Sees Present Photometric Techniques at Limit of Development

by Charles D. LaFond

MIAMI BEACH, FLA.—A practical developmental limit already may have been reached in the missile/space field with conventional photometric techniques and instruments, says Brig. Gen. Harry J. Sands, Jr., new commander of the Air Force Ballistic Systems Division.

While expressing confidence in the future through improvements in other competitive approaches—particularly use of image orthicon tubes with existing electro-optical range instrumentation—the former Eastern Test Range commander declared his doubts that improvements in present systems, such as cine-theodolites, would justify the required high developmental costs.

Speaking here before the ninth annual technical symposium of the Society of Photo-optic Instrumentation Engineers (SPIE) last week, Sands also stressed that even should such range equipment experience a step advancement, difficult problems still must be solved in the processing and reading of film.

Film recording capability is limited, said Sands, processing is too slow and inaccuracies are further degraded by the introduction of the human element during the transfer of data from film to computer tape.

As a result of recent advancements, he disclosed, an image orthicon tube will be mated with a J. W. Fecker Div., American Optical Co., IGOR and later with a Perkin-Elmer ROTI (M/R, June 1, p. 33). Both systems are long-focal-length photo telescopes employed on major U.S. ranges.

The new ALOTS (Airborne Lightweight Optics Tracking System), under development for the Eastern Test Range by Nortronics Div., Northrop Corp., is expected to be ready in 18 months. Pointing out the growing use of airborne platforms for range instrumentation, Sands said the system will be used eventually to support the *Gemini* and *Titan III* development programs and probably will be of great help in recording future space rendezvous and docking operations in various projects.

(ALOTS, carried in an instrumented C-135 aircraft, will employ a 200-in.-focal-length telescope with a 70-mm camera operated at 80 frames per second.)

● **SPIE changes name**—Although last week's symposium was the ninth annual meeting of SPIE, it was the first held by the newly incorporated society under its slightly revised name—the word "photo-optical" was substituted for "photographic," SPIE officials said, to reflect the broader interests of its members.

The five-day meeting at the Deauville Hotel presented over 60 technical papers, three panel discussions, and some 40 exhibits. Nearly 400 attended the symposium, according to SPIE officials.

● **Telespectrograph results**—No spectral data were obtained from the April 14 Project *Fire* re-entry test using the new 8,000-lb. telespectrograph at Ascension Island, according to J. M. Satterfield of NASA's Langley Research Center.

In his paper describing the program and the installation and operation of the big instrument, the NASA engineer noted that the system attained some success in tracking five other re-entry vehicles prior to the *Fire* mission. However, during the latter event, difficulty was experienced by the operator in tracking the re-entry body.

The image, said Satterfield, hit the film only 123 times out of a possible 476, and the images were not held long enough for significant integration of the light energy. Because of the low light levels, he said, the eight infrared detector outputs were not usable.

The system uses a NOTS-China Lake-developed tracking instrument mount and a J. W. Fecker-developed instrument. The telespectrograph includes a 36-in. telescope with spectrographic instrumentation and a recording camera. IR recording is by magnetic tape.

Modifications are being made to the system and further attempts will be made to obtain meaningful spectral data from the *Fire* experiments. ■

New NERVA Reactor Nears Power Test

A MAJOR STEP in the development of nuclear rockets will be taken next month with the first powered firing of the *NERVA* engine's NRX-A2 reactor.

The short-duration, partial-power test is scheduled for late September, NASA officials told MISSILES AND ROCKETS.

If successful, it would go a long way toward gaining eventual Administration approval of flight tests of the Rover nuclear stage for which *NERVA* will serve as the powerplant.

The test will follow shortly after the last firing in the Kiwi reactor series, slated for Aug. 28. This will be a full-power test firing for longer periods than the successful May, 1964, Kiwi-B4D test.

Detailed results of both tests may not be known until the reactors have been dismantled and inspected several weeks after the test, officials said.

The NRX-A2 reactor design was adapted from Kiwi by Westinghouse Astronuclear Laboratory and Aerojet-General Corp. after problems developed during early firings.

The first NRX reactor experiment (NRX-A1) was conducted in March and April, 1964, without uranium in the fuel elements. The test was designed to check structural and flow characteristics under non-power-producing conditions. After the NRX-A2 test is completed, an extended-duration test is scheduled early next year.

AF Outlines Future Solid-State R&D

Continuing government support urged for broad microelectronics spectrum; 800 firms display wares; IC advances evident

(The 1964 Western Electronics Show and Convention was covered by M/R Electronics Editors Michael Getler and Rex Pay.)

LOS ANGELES—Air Force microelectronics expert Richard D. Alberts, chief of the molecular electronics branch of the Air Force Avionics Lab at Wright-Patterson AFB, singled out 13 areas of "future gains" in the microelectronics field which "ought to get continuing government support" at an opening-day session of the Western Electronics Show and Convention (WESCON) here.

Alberts, one of the prime movers in the AF's microcircuit program, was joined in a heavily-attended "invited" Aug. 25 session by Dr. William Webster, director of RCA's Electronic Research Lab at Princeton, N.J., and Robert C. Sprague, chief executive of Sprague Electric Co., North Adams, Mass.

Alberts' list of "future gains" includes:

Application of solid-state integrated approaches to microwave equipments, particularly in receiver front-ends and video strips. Also, use of multiple solid-state low-power devices in transmitters to replace single, more conventional high-power transmitters should be very auspicious for new solid-state phase-array radars which, he states, are on the horizon.

● **Microelectronics discussion**—Alberts urged that the entire area of microelectronics be viewed from the function and subsystem level rather than from the circuit and component level. He said "it is not how we do things that is now important but what we select to do." He urged caution in merely attempting to add capabilities to circuits when there may not be a real need for it.

In this context, Alberts pointed to the two new molecular electronics systems unveiled by the Air Force this spring, one a Texas Instruments-developed telemetry encoder and the other a Westinghouse IR seeker as the means to expand the technology.

Alberts stressed the potential for new functional electronic blocks inherent in the periodical-class III and V compounds, such as gallium arsenide, gallium antimonide, gallium phosphide, and indium arsenide. As active devices, GaAs, in particular, he said, allows higher-temperature operation and higher speed, and also adds the new phenommenon of light emission, which may well open up a whole new field of opto-electronic integrated devices and add a third dimension to the expansion of integrated circuit (IC) arrays.

(Texas Instruments announced delivery Aug. 25 of a new experimental GaAs transistor and opto-electronic pulse amplifier to the Air Force Avionics Lab.)

New IC process specifications which would give a customer a "reliability feeling" rather than reliability data are also apt to become a necessity, says Alberts, due to the inherently long mean time between failure rates believed possible with new IC's.

Removal of packaging from individual circuits in favor of encapsulation of an entire subsystem or system is also apt to lead to the same types of 10:1 size reduction in the future that IC's gave over discrete components.

In other areas, Alberts called for: additional levels of integration, in which perhaps up to 500 individual components are contained in a single silicon chip, allowing shift registers and adders to joint flip-flops and gates; integrated field-effect structures; adaptive elements and systems; thin-film active devices, and thin-film passive techniques made compatible with silicon monolithic technology to combine the two in a high-performance hybrid; and new materials and phenomena research.

● **Low-Cost IC's**—Alberts also pointed out the effort on low-cost custom-design IC's. He noted the significance of the choice of custom silicon circuits (SIC's) for the *Minuteman* guidance computer and its effect on the entire space and defense field. SIC's are now being used in the *Apollo* program and for virtually every military computer now in development.

The Air Force scientist said that the avionics group at Wright-Patterson has been spending about $4-5 million annually in recent years in applicable solid-state technology; he estimated this support would continue and grow as the applications expand. He regards the $10-20 million pumped into microelectronics by the Air Force as "seed money" in comparison to the $200 million which industry has spent in private R&D spurred on by service interest.

The "order of application" for IC's, according to Alberts, will be: digital equipments that can use standard circuits—such as military computers, which all use SIC's; other applications that can use standard circuits; custom designs for high-volume or very important equipments, such as the *Minuteman* computer; and the evolution, eventually, of custom-design equipments when custom circuits can be made cheaply enough. Until that time, efforts will be made where possible to digitize many functions.

While Alberts emphasized the systems view, he did mention some circuit problems, such as second-level wiring, and the need for new 100-mc SIC logic elements, which appear near the state of the art.

● **Record Attendance**—This year's WESCON, at which some 800 firms displayed wares, seemed to be heading for a record attendance, judging from early registrations. Peak WESCON attendance was 44,000 in 1962. This year's turnout was expected to break 50,000.

Main advances in technology evident in the integrated circuits exhibited at WESCON were the availability of

multi-function devices and the promise of circuits with high isolation between individual components.

Now that some manufacturers have developed the capability of putting large numbers of components in a single monolithic chip, they are exercising their option of providing either one complex circuit per chip or a number of simple circuits. The second choice, the multi-function circuit, appeared on the stands of Texas Instruments and Signetics.

TI showed 11 new semiconductor networks (four logic families) that combine two, three, or four circuit functions in a single monolithic bar of silicon. The reduction in package count also reduces interconnections and so promises higher reliability. The equivalent cost per circuit function drops dramatically. In an example quoted by TI, one gate priced at $10 could be bought in units of four in a single package for $12, or an equivalent cost of $3 per gate.

● **More miniaturization**—Signetics is now offering double, triple or quadruple DTL integrated circuits in a single package without increase in chip size. F. J. Van Poppelen, Jr., Signetics executive vice president, predicts even more functions per unit in the future, with a consequent reduction in total systems costs.

Signetics also reports that increasing inquires for integrated circuits are coming from outside the defense market. To meet the anticipated demand, the company has developed two more "utilogic" circuits.

Next step from the multi-function device, says TI, is the use of a number of chips in the same package, without breaking them out from their common substrate. "This is certainly coming soon," said a spokesman.

A more complex advance in technology that a number of companies indicated as imminent is the achievement of high isolation between components in a single substrate by use of moats of silicon dioxide. Signetics indicated a marketing date of about three to six months from now for its devices of this type.

The Signetics process involves the formation of small islands of monocrystalline silicon inside moats of silicon dioxide that separate them from a polycrystalline substrate. Single active or passive components can then be formed in each island. Signetics believes that this will enable the switching characteristics (lifetimes) of individual transistors within a single substrate to be tailored to meet the needs of circuit design. Also, microwatt operation at "very respectable speeds" is expected.

Motorola Semiconductor Products is making available evaluation quantities of an "epic" monolithic DTL integrated circuit that is claimed to be parasitic-free. The device is similar to a standard Motorola DTL gate (voltage ratings are identical), but input and output capacitances are cut by 60% and speed is typically up by 50%. Again, a silicon dioxide isolating barrier is inserted.

Microelectronics at Radiation, Inc., is also developing integrated circuits in which isolation moats are formed in a silicon substrate. Isolation leakage currents of 100 microamps at 1,000v are reported.

● **Broad TI line**—TI brought out 125 new semiconductor products at WESCON. In adddition to the multi-function packages, 33 new integrated circuits were announced, including a family of 15 low-power networks, 10-mc differential amplifiers, and a 5-megohm input-impedance network for use with transducers. A refractory metal contact system employing a layer of gold over a metal such as tungsten or chromium was shown. This permits gold-to-gold bonding and eliminates the purple plague formed on gold-aluminum bonds.

TI also showed a "field relief electrode" technique for eliminating surface inversion in silicon transistors and a 1.5-gc quarter-watt transistor developed under a Navy Bureau of Ships contract.

A decade ring counter in a single silicon chip has been developed by Honeywell. Packaged in a 14-pin low-profile TO-5 can, it has 10 output terminals, a single-phase clock input, a clearing input and two supply terminals. Minimum clock rate in the 0 to 55°C operating range is 200 kc. Each of the 10 stages of the ring consists of two silicon-controlled rectifiers and two PNP transistors. A power supply of 60 mw is required. Applications include programmers, telemetry, analog-digital converters and numerical readout devices.

Raytheon Semiconductor Division is developing an integrated NOR gate, using field effect devices. The six-lead device consumes 3.5 micowatts.

Bendix Semiconductor is producing "mosaic" circuits, offering a circuit designer's kit that resembles a do-it-yourself system for integrated circuits. It consists of a series of large-size paper cutouts of deposited thin-film resistors and capacitors, which a designer can stick to a representation of a diffused master chip containing a number of active elements. The paper model of the circuit is then sent to Bendix, which fabricates the required circuit.

Other companies showing integrated circuits included General Electric, Sylvania, Sprague, Western Semiconductors, Siliconix, Hughes, Amelco, Westinghouse, Hoffman and Nippon Electronics. ■

Inexpensive Missile Guidance System Aired

LOS ANGELES—As usual at open meetings, papers on guidance and control hardware were conspicuously absent from the Astrodynamics, Guidance and Control Conference co-sponsored here by the American Institute of Aeronautics and Astronautics and the Institute of Navigation.

But there was one paper at the meeting last week that stood out as having potential significance for tactical missiles of about 100 miles range. Presented by W. H. Ito and J. E. Tashie of Honeywell, it described P-matrix guidance—an inexpensive inertial guidance technique for missiles such as *Asroc* and *HIBEX*, using strapped-down inertial components.

The equations involved belong to the perturbation class of missile guidance techniques, selecting perturbation of inertial displacement, velocity, roll angle, pitch angle, and yaw angle. The technique can be developed as a modular construction concept with various complexities.

ESRO Considers Delta Purchase

The European Space Research Organization is considering buying 8 to 12 *Delta* launch vehicles for use in launching European-built scientific satellites over a three-year period beginning in 1967.

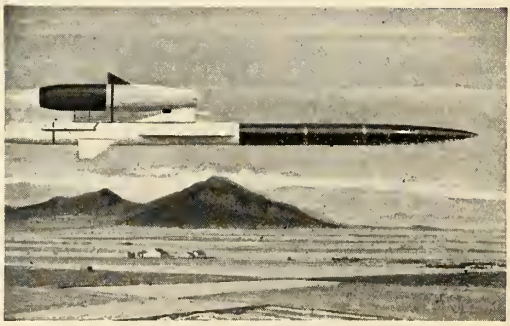
The organization would buy the vehicles and pay the U.S. to launch them, some possibly from the Pacific Missile Range at Pt. Mugu, Calif.

A *Delta* launch, including the vehicles, costs between $3 million and $4 million dollars, but no firm proposal has been received from ESRO by NASA's Office of International Programs, according to Washington officials.

Two European-built satellites are already scheduled for launch in 1967 using *Scout* vehicles through cooperation between ESRO and NASA.



This is the only target missile that can provide realistic training for the Hawk air defense missile. It is the versatile Redhead/Roadrunner official U.S. Army Hawk target.



The Redhead/Roadrunner is the only target missile that can realistically train Hawk missile batteries to defend against a low-level, supersonic attack. It flies at more than Mach 1.2 at 300 to 500 foot altitudes. The Redhead/Roadrunner assures attack realism. It is versatile—also flies Mach 2.0 at high altitudes. Has zero length ground launch. It is recoverable on land and sea. Reliable. Maneuverable. Mobile. It has growth potential...and it is economical. The versatile Redhead/Roadrunner target missile system was designed and is being produced for the U. S. Army by North American Aviation/Columbus Division. It is an official Hawk target. It is the only target that provides a true realistic training situation. And it is available for immediate delivery and service.

North American Aviation Columbus Division

4300 East Fifth Avenue, Columbus, Ohio

Technical Countdown

MATERIALS

Cold Extrusion Method For Refractories

Extrusions of refractory metals with complex cross sections are feasible with the development of a cold extrusion process at Aerojet-General Nucleonics. The feed material is composed of particles ranging from sub-micron to 10 to 20-micron diameters. A proprietary binding system and sintering aids are blended through a planetary apparatus. The extrusions are produced at pressures ranging from 3,000 to 20,000 psi with outside diameters between 0.130 to 0.750 in. The process evolved from nuclear fuel fabrication technology. The green bodies are sufficiently plastic to allow green deformation prior to sintering.

Liquid Lithium Loop Runs Year at 2,000° F.

A large columbian alloy heat transfer system completed a 12-month run at 2,000°F and a power level of 5,000 kw with circulating liquid lithium as the heat transfer fluid at the AEC's Connecticut Advanced Nuclear Engineering Lab. Operated for the AEC by United Aircraft's Pratt & Whitney Division, the CANEL facility simulated the SNAP-50 heat transfer system by using electric heating for the nuclear heat source. The heat is removed from the simulated reactor by a pumped lithium circulation system and transferred through powerplant-type heat exchangers to a pumped liquid-sodium/potassium loop and then to the atmosphere. The year-long test marks a major technological milestone in the development of nuclear-electric powerplant technology because such prolonged operational data with these fluids and alloys was non-existent.

ELECTRONICS

Transistor Surface Inversion Eliminated

A technique called the Field Relief Electrode by its developers, Texas Instruments, Inc., eliminates surface inversion in silicon transistors. The technique avoids the electrical field that is one of the causes of inversion. By neutralizing rather than merely restricting the inversion phenomenon, the electrode allows the use of expanded contacts. Incorporating the Field Relief Electrode in the transistor can be compared to adding an internal shield—with the shield grounded to the device collector. Any appreciable field beginning at the surface of the oxide will terminate at the electrode. Little field will be evident between the electrode and the oxide-semiconductor interface because the electrode is grounded to the collector.

Seismic Communications on the Moon

If ordinary electromagnetic communication on the Moon does not prove feasible, seismic signaling might be used instead, suggests N. Abramson of Stanford University. A potential bandwidth of 30 cps at a low signal-to-noise ratio is offered. Statistical communication theory, developed for electromagnetic waves, has recently been successfully applied to seismic waves. Sophisticated data processing methods and arrays of seismometers provide dramatic improvements in the signal-to-noise ratio of seismic signals.

EOS Operates Sun-Pumped Laser

A 20-lb. sun-pumped laser requiring no electrical power or cryogenics has been developed for spacecraft use and successfully operated by Electro-Optical Systems, Inc. It is the first of its kind, using solar energy concentrated by a lightweight parabolic reflector upon a combination lens and coolant flask that refracts the energy over the length of the 2-in. yttrium aluminum garnet (YAG) laser rod. YAG offers a low lasing threshold and requires little cooling. Coolant used in the lens-flask during lab tests is water. Earlier Sun-pumped lasers have been hampered by a requirement for cryogenic cooling. The YAG is doped with neodymium to fix the output at a wavelength of 1.06 microns. In ground-level Sunlight, the EOS device has produced a power output of 25 milliwatts at 300°K. Company officials claim that a flight version could generate one watt in space and might weigh little more than 10 lbs.

Space Battery Research Under Way at Battelle

A method to improve rechargeable batteries for space satellites is being studied by researchers at Battelle Memorial Institute under contract from NASA's Lewis Research Center. The 12-month program calls for the development of electroformed nickel plaques for use in battery electrodes. One phase of the program will develop the techniques for making the plaques while a second effort will be directed at providing electrochemical data for their evaluation.

General Purpose VHF/UHF Transistor Developed

A VHF/UHF "overlay" transistor with a typical 5-watt power output at 50 mc and 20 db gain is in the early marketing stages at RCA Electronic Components and Devices. Company spokesmen expect to find broad markets in new military and commercial VHF/UHF transmitting equipments since high volume production and low-cost packaging techniques have brought the 2N3553 down to a fraction of the cost of previous overlay transistors.

SPACE MEDICINE

Space Station Simulator Delivered to AF

The new simulator aimed at solving *Manned Orbiting Laboratory (MOL)* problems has been delivered to the Air Force's School of Aerospace Medicine in San Antonio. The 30-ft.-long, 9-ft.-dia. chamber, which also has a 10-ft. airlock, is divided into three compartments simulating the working arrangements of a space station. Seven major biomedical categories will be studied in different gaseous environments. They are: heart, nervous system, digestive system, glandular system, kidney and fluid balance, breathing, and body deterioration and control.

New Design in Electrocardiograms

Beckman Instruments is working on an improved electrocardiogram with spaceflight applications. New electrode design and signal conditioning circuitry—amounting to a state-of-the-art breakthrough according to Beckman—permit almost artifact-free and reliable monitoring. Improved readout techniques make the data much easier to handle, the company says.

Simulators' Shortcomings Described

But meeting at VPI hears that future facilities will nevertheless contribute more to the technology than wind tunnels did to aircraft

by William Beller

BLACKSBURG, VA.—Space simulators will never perform realistically enough to satisfy completely the requirements of space equipment design.

This was the consensus of speakers at the Conference on the Role of Simulation in Space Technology, held recently at the Virginia Polytechnic Institute here under cosponsorship of the National Science Foundation and NASA's Langley Research Center. Nevertheless, the more than 200 space scientists and engineers in attendance were told that simulators will contribute even more to their technology than wind tunnels did to the development of aircraft.

● **No shotgun approach**—There is little merit in general-purpose simulators, said Arthur W. Vogeley, chief of the Guidance Control Branch, Langley Research Center. He said they can not handle special problems with sufficient fidelity, and, furthermore, "they operate almost all the time at less than maximum efficiency." He suggested it would be better to have several special-purpose simulators for almost any type of problem.

Turning to another subject, the speaker complained that ground simulators are not good enough to take an astronaut through a realistic letdown and landing on the lunar surface. For this reason, he noted, some sort of flight simulator may have to be devised.

The main trouble stems from the lack of detail and three-dimensional effects as the simulator attempts close approach. Nevertheless, some type of simulator is needed, even if it represents a compromise, to help in the study of guidance and control systems in the vicinity of the Moon.

To satisfy this need, Langley is building a new facility called LOLA (Lunar Orbit Landing and Approach Simulator). It consists of a pilot's capsule, a closed-circuit TV complex, and models of the lunar surface. There are four such models, each of a different scale, to permit altitude coverage from 200 mi. to 200 ft. above the ground.

A 20-ft.-dia. sphere of the lunar surface, two spherical segments and one flat section are the models for the simulator. These are appropriately viewed through a camera equipped with a single wide-angle 220-degree lens.

This single view is then processed electronically to provide a changing lunar surface as a function of spacecraft motion. The single view is subsequently projected onto a television screen and viewed by four pick-up cameras. These cameras, in turn, will project their separate views through the four port-holes of the space vehicle so that the view in each will correspond to what the pilot will see during his lunar approach.

Langley has already developed a simulator to study the problems of men walking, running or jumping on the lunar surface. In this now-well-known facility, the subject is supported by a puppet-type suspension system at the end of a long pendulum. A floor is provided at the proper angle so that one-sixth of the subject's weight is supported by the floor and the remainder by the suspension system.

A variation of this technique can be used to study locomotion in a rotating space station. One concept Langley is studying, shown here, is called the rotating space-station simulator. As may be seen, the test subject is hung in the sling support and suspension system so that he is initially in a zero-g condition. Then the entire suspension system and the space station are rotated so that artificial gravity is supplied through centrifugal force.

● **A deadly umbilical**—When astronauts leave their orbiting vehicle to do assembly or repair work in space, they bring up one of the most difficult missions to simulate. In particular, orbital assembly may require astronauts to move large masses either through their own efforts or with the help of self-contained, readily attachable propulsion modules (small space tugs), which they directly or remotely control. "Techniques for realistically simulating these situations are non-existent," said Vogeley.

Even the problem of astronaut retrieval is not simple in practice or in simulation. Vogeley assumes that extra-vehicular locomotion will be accomplished with the astronaut tethered to his vehicle by a safety cable. Should some emergency occur, it will be necessary to retrieve the astronaut through this cable. If he is only a few thousand feet from his vehicle and has only a slight relative rotational velocity, conservation of angular momentum during reel-in would quickly result in crushing g-loads on the astronaut.

In order to avoid this problem, much more sophisticated concepts than simple reel-in are needed. One answer may be for the astronaut to unreel his back pack, thereby effectively increasing his moment of inertia and decreasing his angular velocity with respect to his vehicle. In any event, Vogeley said it may be possible to develop small ground-effect machines that can simulate the activity.

● **Lasers for Apollo**—High-powered gas lasers, transmitting signals in short bursts through the ionized sheath of a high-speed re-entry capsule, may be a description of how the *Apollo* re-entry communications system will operate. S. C. Lin, scientist at Everett Research Laboratory of Avco Corp., said the "optical window by far looks like the easiest way to get through the re-entry ionized sheath." He played down the possibility of using electromagnetic signals.

Noting that his company is working on such a laser for *Apollo* applications, Lin said the problem of receiving the beam at ground stations is not as difficult as some people might think. He said the solution lies with degrading the

beam so that it will spread out to a limited extent, thereby lessening the tracking problem.

This method would require more power than that needed for transmission of an entirely coherent beam, but Lin saw no difficulty here. He declined to say, however, how much power would be required—although he did observe that the amount needed is higher than has been quoted in the literature and "can be easily calculated."

On the other hand, another speaker felt that the electromagnetic window is open much wider than the optical. Admitting that some tricks will have to be used, Herbert A. Wilson, Jr., chief of the Applied Materials and Physics Div. at Langley, suggested injecting water into the ion sheath to cool it down, thereby decreasing ionization. This method was tried earlier this year on NASA's *RAM-B* re-entry vehicle.

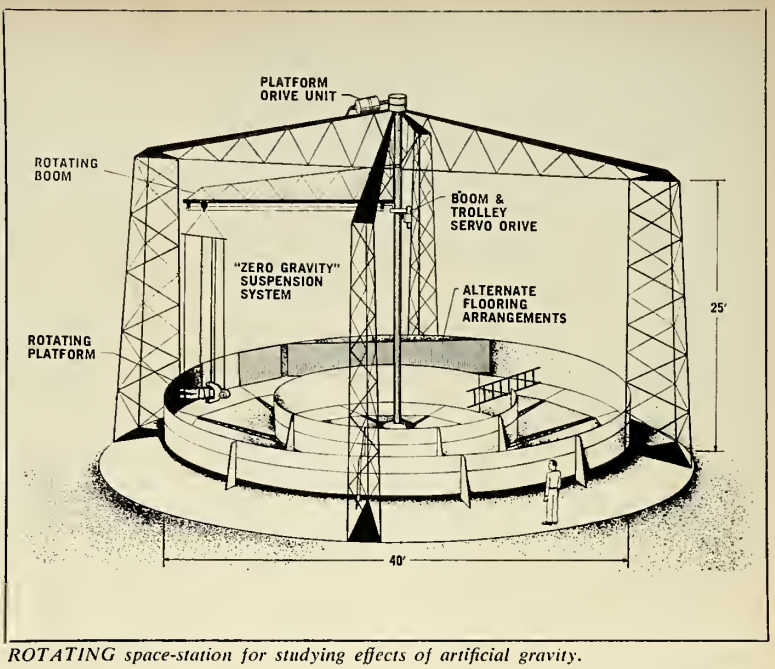
This rocket, whose acronym stands for Radio Attenuation Measurement, carried X-band, C-band, and VHF transmitters. Wilson reported that the VHF blacked out first, then the C-band as the ion sheath grew more dense during re-entry. Yet the X-band was still transmitting when the re-entry speed hit 22,000 fps.

Although Wilson did not disclose any data for speeds greater than 22,000 fps, he indicated that *RAM-B* methods would not do for *Apollo* re-entry communications. Even so, he said he was not pessimistic about the ultimate possibility of sheath-cooling providing an answer. "Judging from flight experiments and ground work on the problem, there is definite hope," he said, "and I think, too, *Apollo* may be able to carry enough water to do the job."

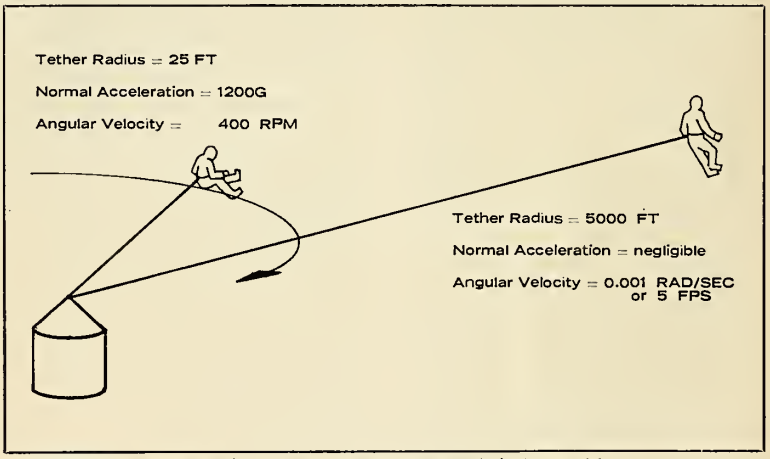
● **Disoriented astronauts**—Take away some of man's sensory inputs, or just diffuse them, and in a short period of time he probably will suffer from some type of delusion. If astronauts experience this—and they surely will, a noted psychologist assured his Blacksburg audience—the aberrations may be severe enough to imperil the mission.

The phenomenon, called "sensory deprivation," described by Sidney Weinstein, director of the Neuropsychological Laboratory of the Albert Einstein School of Medicine, New York, affects even airline pilots. In this regard, Weinstein recounted a case analogous to spaceflight in which pilots flew long hours at altitudes of 40,000 ft., where the sameness of the exterior scene lessens visual inputs. "They began seeing things in the sky that weren't there, and making maneuvers to avoid them."

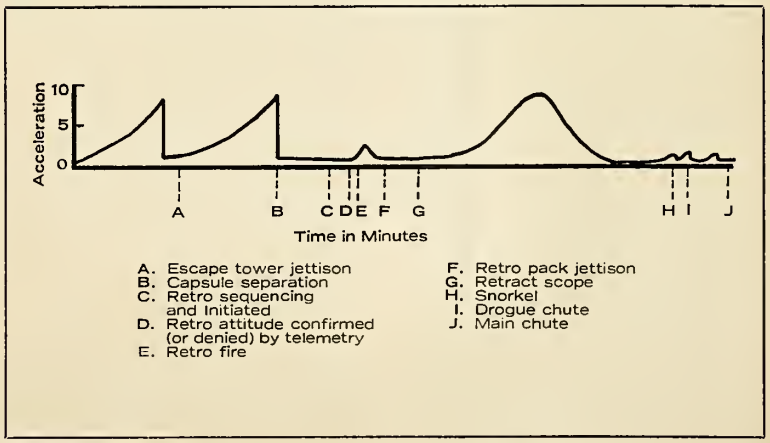
Stressing that even a slight degree of sensory deprivation will have its effects, Weinstein said the major sensory lacks for astronauts will involve weightlessness, unchanging vistas and restriction of pilots' motions.



ROTATING space-station for studying effects of artificial gravity.



TETHERED astronaut takes crushing centrifugal load during reel-in.



APPROXIMATE g-loadings on astronaut during typical space mission.

Parasail To Be Proposed for Gemini

Late flight might still test steerable parachute for land recovery of spacecraft; NAA continuing paraglider development

by Rex Pay

CLEAR LAKE, TEX.—A proposal to use a parasail on a late *Gemini* flight is likely to appear in the next few months in the wake of rapid development of a steerable parachute and impact-attenuation system for land recovery.

The Manned Spacecraft Center here recently awarded a $246,358 contract for 26 drops of the parasail to Pioneer Parachute Co. of Canada, Ltd., Smith Falls, Ontario, to complete the system's development.

An 83-ft.-dia. steerable parasail, drop-tested with a *Gemini* boilerplate by MSC, has shown a lift-drag ratio of 1:1 and turn rates of 20 degrees per sec.

A North American Aviation, Inc., paraglider proposed for land recovery of *Gemini* suffered a severe setback in the Aug. 7 crash of the paraglider and *Gemini* boilerplate at Edwards AFB, Calif., after the test pilot was forced to bail out (M/R, Aug. 17, pp. 9, 14).

North American, however, is continuing paraglider development, and expects an extension of its present contract when it expires in November. Placed in May, 1963, the NAA contract totals more than $22,000,000 and originally called for a June completion date.

The lift-drag ratio of the MSC/Pioneer parasail, combined with its steering capability, enables the spacecraft to avoid local obstacles and to negate winds during a land touchdown.

The parasail development was not begun officially for *Gemini,* but as part of a program to develop a land-recovery capability for second-generation spacecraft. According to the Pioneer contract, however, the parasail will be used to recover *Gemini* and other similar weight spacecraft.

Gemini and *Apollo* are the only two second-generation spacecraft from which design requirements for the parasail system can be generated, and it is highly desirable that any system for *Apollo* should be first demonstrated by *Gemini.* So parasail design has centered on meeting *Gemini* requirements.

Because the parasail has been around for some time and represents a fairly simple advance on conventional parachute technology, its development for spacecraft use has been relatively easy. But the paraglider ran into deployment problems that slowed its development. So much so that, in the first quarter of this year, NASA was pessimistic about land recovery of *Gemini* and predicted that all flights would require water recovery.

● **Schedule crowding gliders**—Ultimately the paraglider, with its promise of superior horizontal flight, may prove the better system. But the stringent deadline on *Apollo* reflects back into the *Gemini* program. The real argument between the two systems is not which will ultimately be better, but which can be fully man-rated in the limited time available.

At the same time, there are other developmental programs for steerable parachutes, notably that at Northrop Ventura under an Air Force contract, which are aiming at glide performance approaching that of paragliders and load capacities suitable for *Apollo.*

Parachutes are a very efficient means of decelerating in the atmosphere. Their drag-weight ratio is high. They are light and easily stowed in a spacecraft, and they are self-inflating, requiring no auxiliary gas system. Present weight-limited spacecraft cannot afford to ignore these advantages.

● **Maneuverable chutes**—The work at Houston with the 83-ft. parasail was a joint effort between Pioneer Parachute Co., the University of Minnesota, and the Manned Spacecraft Center. Development stemmed from sport parasailing in which a man hanging from a modified parachute is towed through the air from a ground vehicle. MSC has used a 24-ft.-dia. parasail in this way to train astronaut flight crews in parachute familiarization.

In its present form, the canopy of the 83-ft. parasail has a semi-elliptical cutout in its solid leading edge and a series of ports or slots in its sides, which exhaust air rearward. Two stabilization panels are added below the canopy on either side. Tested for deployment at dynamic pressures up to 80 lbs. per square foot, the parasail gives a rate of descent of 30 fps. The minimum rate of turn is 10 degrees per second and rates up to 80 degrees per second have been obtained.

The parasail is in fact a very maneuverable system. It is also very stable, showing a maximum swing of ± 3 degrees.

This stability is an important advantage when an impact-attenuation system is used to cushion the final touchdown. It avoids the need for a separate control system to direct the thrust vector of the rocket. The impact-attenuation system will be fired at an altitude of 9 to 12 ft., the firing being initiated by a vertical rod.

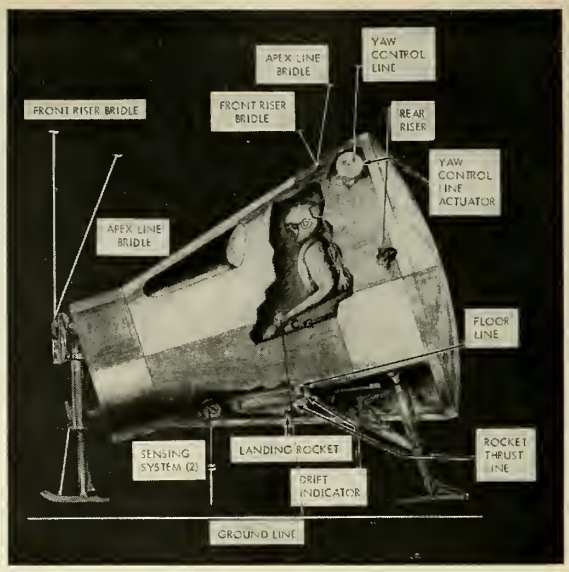
In *Gemini* boilerplate tests now underway, various components are being phased into full-scale systems testing as they become available. Components developed include the 83-ft.-dia. parasail, a radio command system for canopy control from the ground, a television system for providing the ground with a view from the spacecraft, and the impact-attenuation rocket.

In this test series, the parachute is deployed when the vehicle is in the re-entry attitude. After full inflation, the vehicle changes from re-entry to landing attitude. The control system will provide both directional control and adjustment of forward speed.

● **Galveston tests**—Five drops have



ONE-THIRD scale model of Gemini spacecraft and 23-ft.-dia. parasail are shown in test of maneuverable parachute by MSC.



CUTAWAY DRAWING shows how parasail would be affixed to spacecraft, and also shows impact attentuation (landing) rocket

been made over Galveston Bay, Tex., from a C-119 aircraft flying at 11,000 ft., dynamic pressures at deployment reaching about 45 lbs. per sq. ft. Deployment tests of the 83-ft. steerable parachute have been carried out at Q's of 80 lbs. per sq. ft. in bomb drops at El Centro, Calif. Further drops of this type at higher dynamic pressures are planned. The existing system will be qualified for a design Q of 120 lbs. per sq. ft. and MSC will also be looking at a parachute with a heavier payload capability.

The most recent four drops over Galveston Bay have been controlled from a boat, with the parasail making programmed turns to enable measurement of turn rate and acceleration.

The first drop with parasail, remote control, impact-attenuation rockets and rocket initiation sensor will be made in about two weeks. Tests with the television control system will be carried out later.

• **Impact attenuation**—Impact-attenuation rockets manufactured by Thiokol Chemical Corp. have been checked in static firings, and their deceleration capabilities have been verified in crane drop tests.

The altitude sensor for initiating retrofire—a 12-ft. rod— has been carried on the last two boilerplate drop tests.

The rockets have 90-degree nozzles so that they can fire down vertically and thrust through the center of gravity of the spacecraft. Two motors will be located in the lower bay with their nozzles canted about 15 degrees apart when viewed from the front of the spacecraft.

There is adequate structural strength in this part of the *Gemini* operational spacecraft to support such a thrust and MSC says it would not be a major operation to move equipment to make room for the rocket system.

• **Lift-drag modulation**—In the parasail tests underway and planned, MSC has not been modulating the lift-drag ratio. But, by pulling in the slots on both sides of the chute, a partial reversal of thrust can be obtained, cutting the lift-drag ratio by about a third. This technique offers a way of reducing forward velocity without complex lift-drag modulation systems and without high forces (turn forces in the parasail amount to about 100 lbs.)

As one of the chief advantages of a forward velocity is the ability to negate winds, and as winds generally lie in the range of 10 to 30 ft. per sec., ability to alter forward velocity in this way is likely to be of great value.

A steerable parachute with a lift-drag ratio of better than 2 has been designed at Northrop-Ventura. This chute is in an earlier stage of development than the Houston chute, being sized to carry a load of 500 lbs.

Theodore W. Knacke, technical chief of the company's para-dynamics section, points out that a significant bonus gained with this improved lift-drag ratio is that the parachute canopy becomes one third the size of a conventional canopy. When the weight of a suitable flight control system is included, the complete system will be about 50% lighter than a conventional parachute, he said.

• **Flying clover leaf**—In its present form, the Northrop-Ventura parachute looks like three parachutes merged together to form a clover leaf. A self-inflating aerodynamic leading edge is put into one segment of the clover leaf, and a movable panel is inserted into the trailing edge of each of the other two segments. It has an aspect ratio of 1.7—high in comparison with the 1.27 of conventional chutes. The location of the two flaps provides a large moment arm.

In comparison with aircraft aerodynamics, the steerable parachute has very good-natured stall characteristics and does not spin.

Northrop has a $496,000 contract from the Air Force to develop a steerable parachute capable of carrying loads in the 5,000 to 10,000-lb. range. This would give the Air Force the ability to ground-land vehicles up to *Apollo* size. An interesting point is that the current *Apollo* recovery system makes use of three separate 88-ft.-dia. chutes and the clover leaf appears a logical development of this.

Air drop tests of a 12-ft. model of the parachute at Conejo Valley Airport have been satisfactory and the company is now developing a flight-control system for a 52-ft. model to be dropped at El Centro.

MSC acknowledges that development of a parasail big enough for *Gemini* has not been without problems and these have highlighted a difficulty currently facing designers of spacecraft descent systems. This is the fact that early research and development are carried out with very small models and work is then switched to a full-scale vehicle weighing over 4,000 lbs. This large increase of scale throws up a whole new set of problems, and may represent too large a step in development. ■

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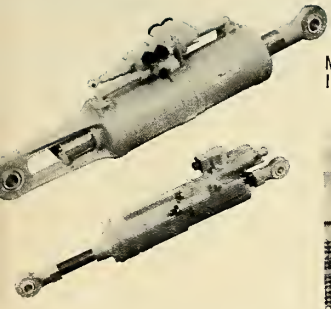
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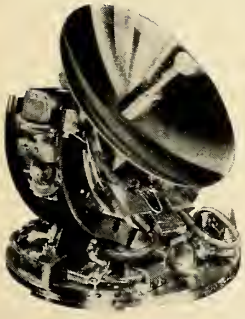
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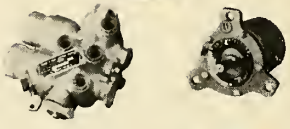


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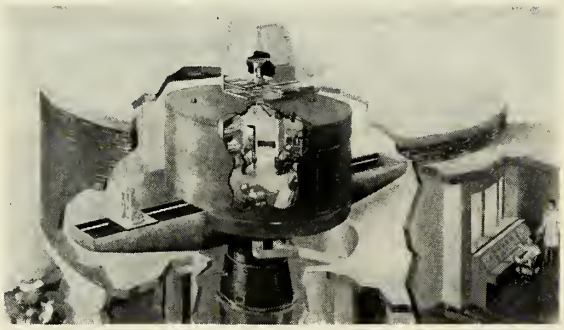
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Navy Gains in Effort to Control 'Canal Sickness'

Graybiel reports Naval School of Aviation Medicine has isolated cause; new facility to aid rotation study

by Heather M. David



NEW 20-FT.-DIA. Slow Rotation Room at Navy school will be used to study reactions to continuous slow rotation, angular and Coriolis accelerations.

RESEARCH AIMED at helping astronauts cope with disorientation associated with spaceflight and weightlessness is paying dividends at the Naval School of Aviation Medicine.

Capt. Ashton Graybiel, U.S. Navy doctor and internationally known specialist in vestibular processes, has reported to NASA that several advances made in the last year will help pin down the causes of disorientation and aid in relieving it.

Among these accomplishments:

—The source of sensation that causes motion sickness—which Graybiel said will be present in spaceflight—has been isolated. It is in the movement-sensing hair cells that detect fluid motion in the semicircular canals of the inner ear. Through experiments conducted in zero-g parabolic flights in a C-135 aircraft, researchers have determined which movements create maximum stimulation.

—Through studying the eye movements of subjects being titled or rotated, the researchers have come up with a means of determining precisely the degree of g-force felt by the vestibular organs, and thus an accurate index of what is happening to the man.

—For the first time, drugs specially designed to overcome motion sickness—which more properly should be called canal sickness—can be compared and evaluated. Some of these, such as streptomycin, may be either beneficial or harmful, depending upon how much is used.

Graybiel now says that canal sickness will be present in spaceflight, but to no greater degree than in ocean travel. Through proper control of head movements much of the trouble can be avoided. It is not expected that astronauts will be affected to the same degree as Soviet cosmonaut Gherman Titov, whose extreme reactions apparently were caused by an individual susceptibility.

The debilitating effects of vestibular sickness have been pointed up all too strongly by the experiences of U.S. astronauts John Glenn, whose trouble resulted from a fall in his bathroom, and Alan Shepard, who has had an infection of the inner ear. There is absolutely no question of either of these experiences being associated with their spaceflights, medics agree. However, both illustrate how seriously healthy men can be affected if something does go wrong in this area.

- **New facility**—The School last month dedicated a new research complex to be used to study problems of rotating spacecraft. The new "Slow Rotation Room" is 20 ft. in diameter and mounted on a 48-ft. track. The capsule can be driven by a 100-hp motor radially on the track at the same time the room is being rotated. In addition, a chair mounted on the track can be moved from end to end of the structure through the room.

The device was designed by researchers at the School in colloboration with KPT Manufacturing Co. of Roseland, N.J.

NASA's Office of Biotechnology and Human Research has been supporting research at the School for several years. One of the prime questions for which an answer is being sought is "what rotation rate can astronauts withstand comfortably if it becomes necessary to rotate a space station to provide artificial gravity?"

Graybiel's group has already extended the theoretical limit of 4 rpm to at least 5 rpm, but is carrying out a number of two-week runs in which subjects try to carry out normal activities in rates from 3 to 10 rpm. At this point, it appears that 10 rpm is not desirable because crew selection would be mandatory, and performance, both mental and physiological, would be decreased.

NASA is also seeking data for human-design specifications for space stations, and for developing equipment and medication to enable the astronauts to function comfortably in the new equipment.

In addition, a great deal is being learned about how to choose crew members who will be least affected, and how to further train them to adapt.

- **Subjects**—Hundreds of subjects have been tested at the School, which until now has depended on a smaller, 15-ft.-dia. Slow Rotation Room. These have ranged from astronauts and jet pilots to deaf persons. Interestingly, some of the deaf persons exhibited practically no effects from certain rotations, depending upon the exact organic cause of deafness.

In addition, experiments are conducted with animals, which by surgery have had one or more of the vestibular organs removed. Through this research, Graybiel has been able to pinpoint exactly what part each organ plays in man's sense of orientation.

- **Flight tests**—An experiment to determine the optical effects on astronauts undergoing acceleration may be conducted during the latter *Gemini* flights. Also, Graybiel has designed a primate experiment for *Biosatellite,* and is working on a ground demonstration of a flight experiment for possible future piggyback rides. ■

Helicopters Will Get Big Hardware Transport Test

North American plans to use helicopters to carry LEM adapters from Tulsa to Cape; too big for more conventional transporters

by Danna Henderson



SIKORSKY S-61 appears most likely to get the transporter job.

THE PRACTICALITY of using helicopters to solve some of the "boat-in-the-basement" problems of transporting out-sized space hardware may receive a full-scale test this fall.

The boats in this case are adapters for the Lunar Excursion Module (LEM), which are being built in Tulsa, Okla., by North American Aviation, Inc.'s Space and Information Systems Div. The basement is Tulsa.

The truncated-cone adapters—22-ft. in diameter at their widest point and 30-ft. high—are too large to be moved by road or rail without costly relocation of obstructions. They are also too large to be flown in the "Pregnant Guppy," a modified Boeing B-377 Stratocruiser.

Further, transporting the adapters to the nearest navigable waterway, the Arkansas River, and thence to Cape Kennedy, Fla., by barge would require an estimated 25 days.

NAA, therefore, under a NASA study contract, has been exploring the feasibility of helicopter transport, and has virtually decided on this solution to its problem.

• **Proposals sought**—The system most likely to be chosen involves carrying the adapters to their three destinations—Cape Kennedy, Huntsville, Ala., and Houston—by means of a hoist arrangement under a Sikorsky S-61 twin-turbine helicopter. NAA has asked several helicopter operators for proposals on the transportation job, slated to begin before the end of the year and continue for several months.

In a proving demonstration earlier this year, Sikorsky Aircraft made an S-61 available for tests with an adapter mockup, and a Sikorsky official told MISSILES AND ROCKETS that carrying the adapter "presented no problems. One flight lasted 45 minutes, and all we can say about it was it was uneventful."

The 4,700-lb. adapter was hoisted by a "shepherd's crook" system similar to that used for recovery of the *Mercury* capsules, and was flown at speeds of up to 85 knots.

For the actual move of the more than 20 adapters, Sikorsky proposes to fly at speeds of about 70 knots. The company estimates the trip to Cape Kennedy could be made in 14 hours of flight time, with five to seven stops, and a total trip time of two or three days. The manufacturer stands ready to offer an S-61 for sale to operators interested in bidding on the job.

• **Trailblazing**—If the LEM adapter move proves feasible, Sikorsky feels it will portend the use of helicopters on a sizable scale for movement of unwieldy space hardware. Although described as expensive (no firm cost figures are yet available), Sikorsky said helicopter transport offers speed and the convenience of carrying the object directly to its final destination and putting it in place.

"If you move something by barge or plane," the official said, "you are still faced with the problem of transporting it from terminal to launching pad, which adds to the expense." Larger "flying crane" helicopters now under development could carry objects several times larger than the LEM adapter, he pointed out.

A second method of transporting the adapters has been proposed by Bell Helicopter Co., but its feasibility has not yet been demonstrated. This system couples a Bell 204B helicopter with an unusual "balloon with a hole in it." A major advantage is that the adapter would be surrounded by the balloon and thus protected from damage in the event it became necessary to release the load in flight.

The balloon, which would be towed by a Bell 204B helicopter, would be approximately 130 ft. long and 35 ft. in diameter. It would incorporate a cut-out area the size and shape of the LEM shroud. Bell calculates that cruising speeds of about 60 knots would be possible with this arrangement. ■

Ultrasonic Ring Welding May Yield Truly Leak-Tight Metal Containers

Harold L. McKaig, Jr.
Vice President
Aero Projects, Inc.

Charles Zglenicki
Industrial Engineer
Picatinny Arsenal

ULTRASONIC RING WELDING methods developed at Picatinny Arsenal, Dover, N.J., may solve the problem of achieving a true helium leak-tight metallurgical closure of propellant and explosive materials containers.

Corrosion-resistant metallic containers are the most desirable means of encapsulating such materials, but a reliable method of sealing and closing such containers—precluding atmospheres, vapors, and other foreign matter from degrading encapsulated material—has not been available.

Picatinny Arsenal, under contract with Aero Projects, Inc., West Chester, Pa., initiated a project to investigate and demonstrate the feasibility of utilizing ultrasonic welding to seal propellant containers.

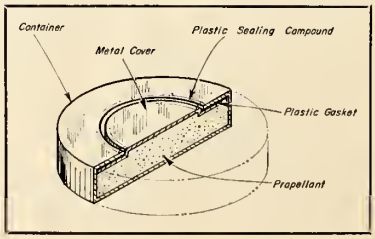
Ultrasonic ring welding, wherein a 360-degree angular weld is produced with a single power pulse of less than 1-second duration, appeared to be the natural approach to sealing circular containers. Ultrasonic ring welds have demonstrated physical strength equal or close to that of the parent metal. The welds achieved were metallurgical bonds of integrity, and were helium leak-tight at test sensitivities of approximately 1×10^{-10} cc/sec.

Adequate seals for large quantity applications have been made with heavy threaded caps or metallic, gasketed, bolted covers, but such methods are not well suited to small packages such as detonators, separation charges and other fusing mechanisms. For these, a small, lightweight package is necessary. In addition, it is frequently desirable to have a closure of a controlled foil-gage metal to provide a rupture disk with predetermined physical properties.

● **Current techniques**—A common method of sealing small quantities of propellant is a crimping technique that incorporates a plastic gasket within the fold of the crimp. To further improve the seal, a plastic material is applied externally to the package over the crimped edge to close any small air channels introduced by the crimping operation. Under controlled storage conditions, the crimped and plastic seal assembly affords adequate protection to the propellant. Under more realistic storage conditions, however, where the containers are subjected to thermal-cycling, ultraviolet from daylight, water vapor, solvent atmospheres, and other more corrosive environments, the plastic sealant is subject to degradation, causing contamination and loss of effectiveness of the propellant.

The creation of a leak-tight bond in small metal containers can be produced by normal fusion welding, which literally melts the container enclosure into a single unit; however the method obviously produces temperatures far in excess of that required to cause propellant ignition. Cold, or pressure, welding could be utilized, but the degree of cleanliness required for the metallic parts presents problems. The material deformation involved precludes the use of very thin foil closures.

TYPICAL set-up for ultrasonic ring welding of propellant container assemblies.



Ultrasonic welding appears to be the best route to a hermetic, metallurgical closure for propellant container assemblies. Heat involved in this process is localized in the extreme center of the weld area, and is of very short duration. They do not peak to more than 30% of the material melting temperature. Mass temperatures of the parts being welded seldom exceed temperatures that would be considered warm to the touch. Pressures involved are not great, and result in a weldment deformation of only 1 to 2% of the total material thickness.

Ultrasonic welding has demonstrated the ability to produce sound metallurgical bonds in thin foils of most materials (particularly aluminum) to a minimum thickness of 0.00017 in. Such bonds or welds are consistently helium leak-tight.

● **Production set-up**—The ultrasonic ring weld is produced by clamping the metal to be welded between a supporting mass or anvil and an ultrasonically activated ring-type welder tip. The welder tip is activated in an oscillatory rotational mode wherein the amplitude of vibration is parallel to the face of the weldment. In this case, the high-frequency alternating electrical current induces an alternating field around the magnetostrictive transducer, and is converted to mechanical vibration.

The mechanical vibration is elastically transmitted through a coupling member. The member is joined tangentially to a rod or tubular section, known as a sonotrode, which is driven with a torsional vibration. The sonotrode, which operates at a resonant frequency, activates the welding tip. The geometry of the welding tip establishes the ring-weld diameter and weld width.

Because a contolled static force is

ultrasonic welds, an existing propellant container assembly was modified to incorporate an outward flange around its mouth. A flat metallic disk cover, having the same outside diameter as the cup flange, provided the closure.

The cup was fabricated from 0.010-in. thick aluminum to provide adequate material for drawing and forming. The cover was made from 0.003-in.-thick aluminum foil to maintain proper rupture characteristics. Type 3003 aluminum alloy was used for both components, since it is readily weldable and has good forming and drawing properties.

A laboratory-type ultrasonic ring welding machine was modified to incorporate a disc-type anvil with a cylindrical recess in the center of proper size to accept the formed aluminum cup. An ultrasonic ring welding tip was designed and used to position the weld area in the center of the cup flange width. The ultrasonic ring-welding equipment used in the feasibility demonstration was an 18-kw welding head powered by a 5-kw motor-alternator delivering electrical power at a nominal frequency of 15 kc.

With this equipment, a welding program was initiated to establish machine settings capable of producing sound, leak-tight closures between the 0.003-in. aluminum cover and the 0.010-in. aluminum propellant container. Based on manual peel-test criteria, wherein the weld nugget must pull out of the parent sheet prior to separation of the weld, it was found that satisfactory closures could be achieved at power levels of 1,300 to 1,800 watts, using a clamping force of 550 to 650 lbs. at weld pulses ranging from 0.5 to 1.5 seconds.

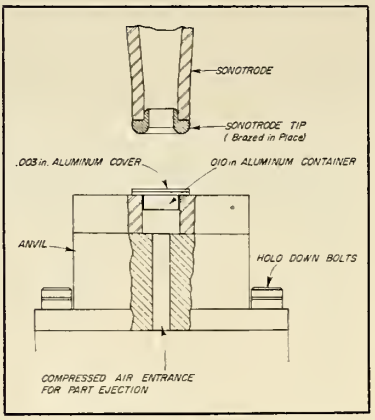
The combination of the higher power levels and the longer welding pulse intervals resulted in slightly more deformation of the cover discs, but yielded acceptable assemblies. The production of strong welds over the wide range of welding parameters illustrated the lack of criticality of the 3003 aluminum alloy to welding conditions.

The acceptability of the established welding machine settings in producing sound welds was confirmed by metallurgical evaluation and by helium-leak testing.

● **Bench verification**—Weld sealing characteristics were substantiated by helium-leak testing on a Veeco Model MS-9AB mass spectrometer. None of the test assemblies showed helium leakage when tested at a sensitivity level of from 3.8×10^{-10} to 2.65×10^{-10} cc/sec. under STP conditions. The helium-leak test procedure required the puncturing of the cover disc to evacuate the container, making the test unusable for inspection of filled container assemblies. Therefore, an alternate leak test was used to confirm the leak-tightness of loaded containers.

The alternate method consisted of submerging welded assemblies in deaerated water, forming a partial vacuum over its surface, and visually inspecting for bubble formation. A partial vacuum of 200 mm Hg. and a waiting period of 5 to 15 minutes were established as test criteria.

After the selection and substantiation of the welding machine parameters, container assemblies containing a propellant simulant were fabricated and tested. This phase of the program involved the welding of 1,000 assemblies containing dry calcium chloride for testing by Picatinny Arsenal. These assemblies were welded using machine settings of 1,300 electrical watts, 550 to 650 lbs. clamping force, and a welding pulse interval of 0.5 second.



TYPICAL set-up for ultrasonic ring welding of propellant container assemblies.

One hundred container assemblies were tested by the water submersion method. None of the assemblies showed indication of leakage. Control specimens, three welded after each run of 100 calcium chloride filled assemblies, were helium-leak tested, again showing no leakage at sensitivity rates as low as 2.65×10^{-10} cc/sec.

Another lot of 133 containers filled with calcium chloride were JAN-cycle tested for 28 days with no evidence of leakage. Still another lot of 100 containers were exposed to 100% humidity for 2½ months with no evidence of leakage to the calcium chloride.

With the fact established that ultrasonic ring welding was capable of making hermetic, metallurgical closures in typical aluminum propellant containers, the problem remained of determining if the propellant would be ignited by the temperature of imposed vibratory energy.

In initial determination tests, a small quantity of M9 propellant was placed in the center of the weld-enclosed area between two flat sheets of aluminum simulating the propellant container and cover. There was no sign of ignition.

Tests were continued in which a generous sprinkling of propellant flakes not only covered the weld enclosed area, but also were dispersed at the interface of the weld itself. After welding, the sheets were manually peeled and the propellant grains examined. There was no indication of propellant ignition. Because no attempt was made during these tests to establish a leak-tight seal in the area of the powder inclusion in the weld, some of the welds were substandard in quality.

● **Acid test**—After demonstrating that ultrasonic welding in the presence of propellants is not hazardous, containers filled with M5 propellant were assembled. Approximately 250 assemblies, processed in the same manner as the calcium chloride filled asemblies, were prepared for solvent atmosphere and closed bomb testing at Picatinny.

A 10% water-submersion testing of the assemblies showed no signs of leakage. Quality control specimens randomly prepared during the run of propellant-filled containers were helium-leak tested, and again showed no sign of leakage.

The containers filled with propellant were temperature cycled 20 times from −65° to 160°F over a one-week period prior to exposure to solvent. The containers were then exposed to a saturated atmosphere of acetone and cyclohexanone at ambient conditions for 15 days. As a control sample, a quantity of containers sealed by crimping and imbedded into a silastic sealant were similarly exposed. After completion of the exposure tests the propellants were ballistically tested in a closed bomb apparatus. This phase of the test determines the effect of the solvent exposure on the burning characteristics of the propellant.

Absorption of as little as 1% of these solvents has a marked effect on the relative quickness of this propellant. (Relative quickness is an expression of the rate of change of pressure in the closed bomb with time.) A pressure time trace is obtained and the average relative quickness expressed as a percentage of the standard value for the propellant. The control samples (sealed with silastic) were contaminated by the solvents and had essentially 0% relative quickness.

The ultrasonic sealed containers were found to produce a 98% average relative quickness. This is considered to be the limit of reproducibility for the test. Based on these tests, the ultrasonic welded containers were considered to have been hermetically sealed. ■

Boeing Official Sees Reliability As Chief Molab Systems Hurdle

SEATTLE—Reliability is the chief requirement to be met by the electronics systems in the *Mobile Lunar Laboratory (Molab)*, according to Marvin Reeves, manager of the study currently underway at the Boeing Company's Aerospace Div.

He pointed out that *Molab* has to have the ability to remain 6 to 12 months on the Moon before use. This is necessary to meet possibility of a delay in launch schedules. Apart from reliability there apparently are no serious problems in the electronics system.

Boeing is the principal contractor in a team studying the *Apollo* logistics support system for NASA. About 90% of this study is concentrating on a two-man mobile laboratory concept. Other members of the team are Radio Corp. of America, Garrett AiResearch Div. and General Motors Defense Research Laboratories.

A competitive study is being carried out by a Bendix team including Lockheed Missiles & Space Company and Hamilton Standard Div. of United Aircraft Corp.

Reeves said that the 6,000 to 7,000-lb. *Molab* would be automatically unloaded on the Moon from a LEM truck launched by a *Saturn V*. The mobile laboratory would then be checked out and maneuvered by commands from NASA's Manned Spaceflight Control Center. Later two astronauts would land in a LEM (Lunar Excursion Module) and they or MSCC would drive the *Molab* across the Moon's surface to their landing site by remote control.

Having transferred from LEM to *Molab*, the two astronauts would explore the lunar surface for a period of up to two weeks.

Molab's maximum speed would probably be 10 mph and its range would be strongly dependent on the lunar surface characteristics.

● **Power requirements**—Studies on the size of the on-board power plant, which will be fuel cells, show this to be very much a function of lunar surface characteristics, because propulsion power is going to be a major part of the load, said Reeves. A yielding sandy type of surface could markedly increase power consumption and restrict range and operating life.

GM Defense Research Laboratories envisages a six-wheel vehicle with three flexibly connected axles. The wheels would probably be formed out of spring steel wires and covered with steel mesh. Tests with vehicles of this type show that with a wheel diameter of about 5 ft., the vehicle can climb a 10 ft. step.

The on-board television system is a key item in the *Molab* instrumentation. It will be used to control and monitor the vehicle from Earth, it will play a part in the navigation and guidance system, and it will be used for scientific examination of parts of the lunar surface.

● **Windshield problems**—The astronauts in the vehicle will probably have a window to look through, but its design and location present problems. Chief unknown at present is the extent to which the window will be degraded by micrometeorite ejecta. If it takes the form of a bubble mounted on top of *Molab*, the vehicle structure itself would provide some shielding.

The bubble window "is a real interesting possibility," said Reeves. Whatever form of window is chosen, the television system will provide additional observation flexibility. "We never want to lose sight of the fact that this is an exploratory vehicle," said Reeves. "Also the more he (the astronaut) can do without going into and out of the vehicle the better, because this saves oxygen."

The significant and unusual feature of the *Molab* television system singled out by Reeves was the very wide dynamic range over which it has to operate. Lunar light levels can vary from about 260 candles per sq. ft. (Sunlight) to about 0.002 candles per sq. ft. (Earth shine).

Albedo of the lunar surface material is very low and appears to have little contrast. One result is that shadows on the lunar surface may be a considerable hazard. Without the light scattering provided by an atmosphere, objects within a shadow, or the depth of holes, cannot be seen. This will probably call for the use of some form of secondary light source on *Molab*.

In the present study, Boeing is going to specify the requirements for the *Molab* television system and RCA will decide how to fulfill them.

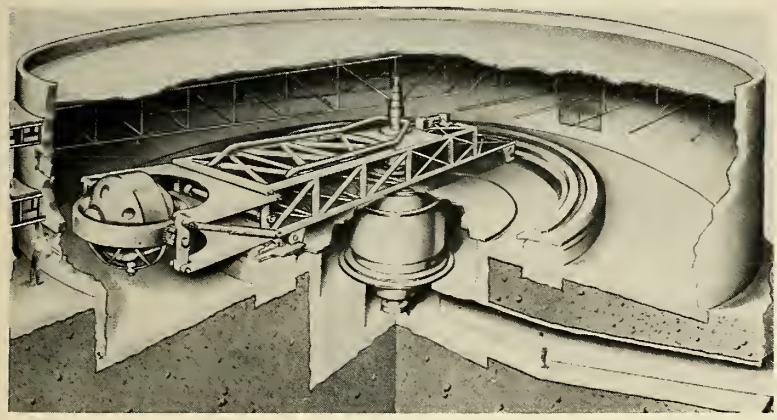
● **Communications and C & C**—RCA is also responsible for communications and command and control in the vehicle. Boeing is going to handle problems of checkout and telemetry, which fan out through the vehicle.

Reeves pointed out that checkout of *Molab* is going to be a complex thing. Many people need to know the status of the vehicle—staff at the Manned Spaceflight Control Center, the crew in the in-flight Command Module, and, subsequently, the astronauts who enter *Molab*. In the 6 to 12-month waiting period before the laboratory is manned, it would be started up and checked out periodically. During manned operation, a very important aspect will be the transmission of information back to Earth to enable monitoring of subsystems with the idea of predicting possible malfunctions.

Because the LEM will be empty when *Molab* is occupied, the main communications links from *Molab* will be to the Command Module and to MSCC on Earth. In fact, scientists on Earth will be looking over the astronauts' shoulders into the *Molab* TV system and will be advising on maneuvers that should be carried out—suggesting, for example, which rock formations should be examined in more detail.

Communications will make use of the unified S-Band equipment and as much *Apollo* gear as possible. The fact that communications between LEM and *Molab* are not required avoids the problem of point-to-point communications on the Moon. ■

Ames Centrifuge To Be 'Most Sophisticated'



CENTRIFUGE main drive—one of the largest of its type—will peak at 15-20,000 hp.

MOFFETT FIELD, CALIF.—A centrifuge that NASA believes will provide the most complete man-carrying space-flight motion simulator available is expected to be in operation here in two years.

The motion generator, for which two detachable simulated space capsules—one carrying a three-man crew—are being designed, will be the heart of the space agency's $9.8-million Space Flight Guidance Facility at Ames Research Center.

It is being designed and constructed by Genisco Technology Corp. under a $6.5-million NASA contract.

Paul R. Radach, Ames project manager for the new facility, told MISSILES AND ROCKETS the motion generator is "the most sophisticated machine of its kind ever attempted." He emphasized it is a research device, not a trainer, intended for mission research beyond Project *Apollo*, although *Apollo* astronauts are expected to log some time in it, perhaps in a simulated command or lunar landing capsule.

Hung in a gimbal fixture at the end of a 50-ft. boom, a capsule will be capable of motions about three flight axes. Acceleration capability will be up to 50 g, at an onset rate of 7.5 g per second above 2 g.

• **High acceleration**—One of the device's unique features will be its high acceleration capability for large payloads. Its rotary inertia is expected to exceed 2.5 x 10^6 slug-ft.^{2}

The simulator's motion capability adds up to five degrees of freedom plus a three-axis vibratory system. In addition, an environmental control system will provide temperature, humidity, pressure and gas flow capabilities that will enable simulation in the capsule "every known factor of control and navigation of space flight except weightlessness."

The device will simulate a partial or complete space mission from launch through mid-course flight, re-entry and landing under both normal and abort conditions. A function of the arresting gear will be simulation of soft landings on the Moon or planets.

Main use of the system will be for research into control and navigation. For this purpose a three-man capsule is being designed. A one-man capsule will be equipped for a secondary use of the system—advanced physiological research.

A vertical motion system will translate the capsule through ± 2 ft., providing accelerations of 2 g downward and 1 g upward. ■



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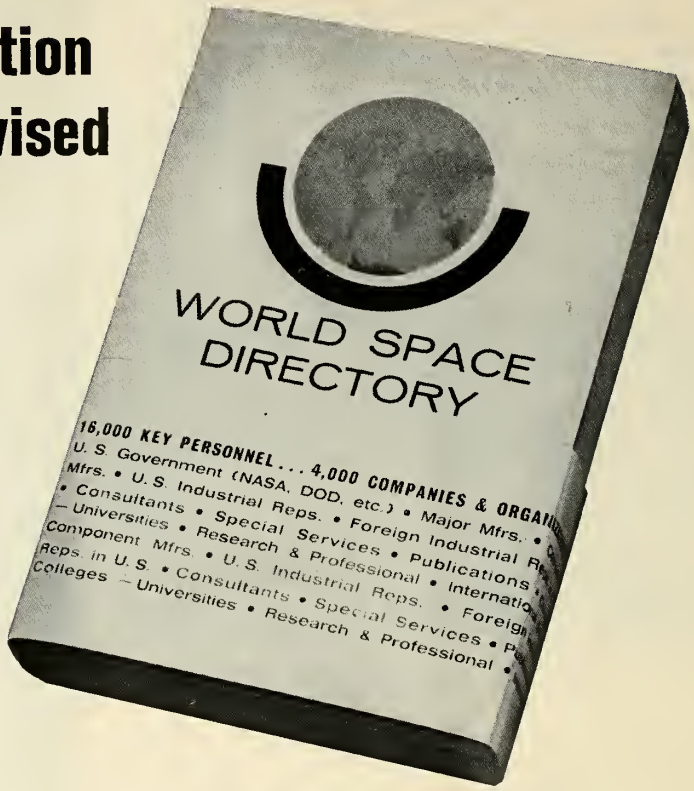
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Mergers and Acquisitions

Microlab, Livingston, N.J., has contracted to buy Amphenol-Borg Electronics Corp.'s line of microwave test equipment, including the FXR name. Microlab will take over the Woodside, N.Y., operation on Sept. 1. . . . *Computer Equipment Corp., Los Angeles, has purchased controlling interest in Vega Electronics Corp. of Santa Clara, Calif. Vega produces and markets wireless radio microphones and related FM receiving equipment.* . . . The Bendix Corp. has signed an agreement to aquire the business and assets of Pierce-West, Inc., Fort Lauderdale, Fla., for cash. Pierce-West manufactures precision spindles used in precision measuring machines, rotary inspection tables, precision finishing and measuring machines, and precision steel balls. The Ft. Lauderdale firm will become the Micrometrical Div. of Bendix and continue operation in its present location. . . . *Servomechanisms, Inc., has acquired production and sales right to angle-of-attack equipment manufactured by The Cosmodyne Corp. of Hawthorne, Calif. Missile applications of the equipment include angle-of-attack sensing for aerodynamic portions of missile flight.*

Firms and Divisions

The Sperry Rand Corp. has established a Solid State Sciences unit at its Sudbury, Mass., Research Center. Three new departments have been created to form the group: Exploratory Studies, Applied Physics and Analytical Chemistry. Purpose of the move is to facilitate progress of the Center's research programs leading to advances in microwave circuit components, electro-optical devices and micro-electronics. . . . *The Solid State Instruments Corp., formerly of Cambridge, Mass., and now located in Boston, has changed its name to Inland Controls, Inc. The change was made to more closely identify the firm with its sister company, Inland Motor Corp. of Radford, Va. ICI will also add to its market line of precision rate tables and gyro test instruments Inland Motor's electronic servo components. Both companies are subsidiaries of Kollmorgen Corp.* . . . The Boeing Company has changed the name of its Industrial Products Div. to the Turbine Div. The division develops, manufactures and sells small gas turbines with power ratings less than 1,000 hp. The division also conducts extensive research and development in specialized turbine areas such as compressors, high temperature operation, combustion regeneration and metallurgical.

Missile/Space Facilities

Burns and Roe, Inc., a New York construction company has announced it is nearing completion of a new propulsion test facility designed to check out engines for the Lunar Excursion Module at NASA's Propulsion Systems Development facility, White Sands, N.M. The facility consists of two altitude test stands flanking an atmospheric test stand. Each altitude test stand includes a fully instrumented altitude simulation chamber, a diffuser-ejector system and space vehicle and dome handling equipment. . . . *TRW Space Technology Laboratories has dedicated a new million-dollar center in Redondo Beach, Calif., to produce micro-electronics for use in spacecraft. In process at STL are microelectronics projects connected with the Lunar Excursion Module and other manned and unmanned programs.* . . . Hewlett-Packard Co., Palo Alto, Calif., has announced plans for a major expansion of its headquarters plant in Stanford Industrial Park. Construction on the three-story 120,000-sq.-ft. building, plus an underground warehouse containing another 50,000 sq. ft. of floor space, is expected to begin this fall. Completion is scheduled for October, 1965. The $2.5-million project is to provide space for the firm's engineering and customer service activities. . . . *Avco Corp's Industrial Products subdivision will move into large quarters in North Wilmington, Mass., in September. The subdivision manufactures specialized coating and composite material systems, including plasma coating equipment.* . . . Electro-Tec Corp., Ormond Beach, Fla., manufacturer of slip rings and electromechanical relays and developer of an experimental flat screen indicating device, is expanding facilities in Ormond Beach and in Blacksburg, Va. Some 20,000 sq. ft. of floor space will be added to the Blacksburg plant, and 8,000 sq. ft. to the Ormond Beach facility. . . . *The Sprague Electric Co., North Adams, Mass., has awarded a contract to construct a new Washington Development Center for its Filter Div. The 6,000-sq.-ft. center is to be located at Annapolis Junction, Md., just outside Washington, D.C. It will offer electromagnetic compatibility engineering and laboratory testing services to industries and Government agencies in the mid-Atlantic and southern states, as well as interference control and electric wave filter design engineering services.*

Company Representatives

Texas Instruments, Inc., Dallas, has named V. Avis McCorvey & Co., Decatur, Ga., Southeastern states sales representative for its resistor and capacitor products. . . . *Huggins Laboratories, Inc., Sunnyvale, Calif., has appointed TRITEK, Inc., as technical representative in the New England area. TRITEK, located in Lexington, Mass., will represent Huggins complete line of microwave components and will offer application and technical sales service.* . . . Electro-Optical Instruments, Inc., Monrovia, Calif., has named Instruments for Measurements, Inc., of Hollywood as sales representative for California and Nevada. Instruments for Measurements will handle EOI's ultra-high-speed photographic equipment and electro-optical laboratory instruments.

AWARDS

AIR FORCE

$27,000,000—**Aerojet-General Corp.,** Sacramento, Calif., for initial segment of a contract totaling $56.2 million to make, test and deliver motors for *Minuteman* missiles.

$3,085,000—**North American Aviation, Inc.,** Anaheim, Calif., initial award on a $12.5-million contract to modernize *Minuteman* guidance and control systetms.

$1,386,504—**Ryan Aeronautical Co.,** San Diego, Calif., for additional materials for Air Force drone radar systems.

$1,238,000—**Thompson Ramo Wooldridge, Inc.,** Redondo Beach, Calif., for engineering support for the *Minuteman* program.

$1,200,000—**General Telephone & Electronics Corp.,** Sylvania Electric Products, Inc., New York City, for the production of electronic security systems to help guard *Atlas* and *Titan* intercontinental ballistic missile launching sites.

$1,200,000—**Fairchild Camera and Instrument Corp.,** Space and Defense Systems Div., Syosset, N.Y., for a quantity of new panoramic reconnaissance systems.

$500,000—**Cook Electric Co.,** Tech-Center Div., Morton Grove, Ill., for 39,000 magnetic tape cartridges.

$437,230—**ITT Corp.,** Federal Electric Corp., Paramus, N.J., for operation and maintenance of the North Atlantic Radio System (NARS).

$181,000—**Thiokol Corp.,** Alpha Div., Huntsville, Ala., for M60 rocket motors, complete with igniter and engineering data.

$94,000—**The Bissett-Berman Corp.,** Santa Monica, Calif., for research, development and test evaluation of a passive optical satellite detector incorporating a new concept for discriminating targets from stellar background.

$39,935—**Rocket Power, Inc.,** Mesa, Ariz., for couplings and probe assemblies for use in *Atlas F* missile.

The Bendix Corp., North Hollywood, Calif., for R&D on a new, highly advanced radar receiving system (amount undisclosed).

ARMY

$10,015,741—**General Dynamics Corp.,** Pomona, Calif., for continued R&D on the *Mauler* surface-to-air missile.

$4,481,965—**Philco Corp.,** Philadelphia, for two contracts for continued R&D on *Shillelagh* missile and manufacture of surface test models of radar surveillance systems.

$2,000,000—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., increment to a previously awarded cost-plus-fixed-fee contract for continued research and development of the *Shillelagh* guided missile.

$1,615,000—**Zero Manufacturing Co.,** Burbank, Calif., to make launching facilities at Merritt Island Launch Area, Fla.

$194,802—**Stone Construction Co.,** Houston, for an astronaut physical training facility.

$125,861—**Raytheon Co.,** Andover, Mass., for repair parts for *Hawk* missile system.

$91,165—**Hughes Aircraft Co.,** Space Systems Div., El Segundo, Calif., for a re-entry study.

$47,197—**Braddock, Dunn & McDonald,** El Paso, Tex., for studies of nuclear radiation vulnerability of the *Sergeant* weapon system.

$41,000—**Hughes Aircraft Co.,** Culver City, Calif., for development and delivery of a laser pulsed oscillator, advanced development model and technical reports.

$28,534—**Hayes International Corp.,** Birmingham, Ala., for replenishment repair parts for *Pershing* trainer system.

Emerson Electric, Electronics & Space Div., St. Louis, for ballistic compartment cases for the warhead of the *Lance* missile (MGM-52) to be designed and fabricated (amount undisclosed).

NAVY

$6,954,252—**General Precision, Inc.,** Glendale, Calif., for manufacture of a submarine fire-control system for *Subroc* rocket-assisted torpedo.

$6,000,000—**RCA,** New York City, to install an unparalleled network of seven advanced computers as part of a unique electronic management information system linking key industrial naval air stations in the U.S.

$1,500,000—**Interstate Engineering Corp.,** Interstate Electronics Corp., Los Angeles, to begin work on portable ship instrumentation packages to use in support of the *Polaris* program.

$1,857,120—**Laddie Laboratories,** Morganville N.J., for oscilloscopes.

$1,222,000—**Northrop Corp.,** Nortronics Div., Palos Verdes Estates, Calif., for modification of two ship's inertial navigation systems to be used aboard Eastern Test Range tracking ships. First installation to be aboard USAF H.S. Vandenberg.

$1,191,156—**Defense Electronics, Inc.,** Rockville, Md., to design and manufacture two instrumentation packages for use in support of *Polaris* missile tests.

$261,000—**The Bissett-Berman Corp.,** Santa Monica, Calif., to build four heavily instrumented taut-moor buoys to collect oceanographic and meteorological data in the Sea Test Range of the Pacific Missile Range.

The Te Co., Santa Barbara, Calif., for research on optical processing on image tube systems as part of Project Defender (amount undisclosed).

North American Aviation, Inc., Atomics International, Canoga Park, Calif., for flight tests of an atomic radiation fuel gaging system (amount undisclosed).

NASA AND AIR FORCE

$122,000—**ACF Industries, Inc.,** Electronics Div., Riverdale, Md., joint contract for a visual display system which can be viewed from a simulated space vehicle.

NASA

$27,000,000—**RCA,** New York City, to build 19 ground computer systems to be used for the checkout and launch of the *Saturn IB* and *Saturn V* launch vehicles.

$4,600,000—**TRW Space Technology Laboratories,** Redondo Beach, Calif., for mission analysis and trajectory simulation for the *Gemini* and *Apollo* spacecraft.

$1,500,000—**J. H. Lawrence Co.,** Baltimore, for maintenance, alterations and minor construction work at the Goddard Space Flight Center, Greenbelt, Md.

$940,000—**Aircraft Armaments, Inc.,** Cockeysville, Md., to design and construct a very large and precise laboratory instrument to be used to test satellites in varying magnetic environments.

$365,000—**Ling-Temco-Vought, Inc.,** Astronautics Div., Dallas, for space environment simulator test program.

$335,791—**Lockheed Aircraft Corp.,** California Co., Burbank, Calif., for thermal analysis of *Apollo* service propulsion system.

$96,000—**Ling-Temco-Vought, Inc.,** Aeronautics Div., Dallas, for a study for the acquisition of lunar surface data.

$53,200—**RCA,** Missile & Surface Radar Div., Moorestown, N.J., for applications study for AN/FPS-16 Mod 1 and AN/TPQ-18 radar.

$36,600—**Westinghouse Electric Corp.,** Astronuclear Lab., Pittsburgh, for thermoelectric power modules.

$27,700—**Lockheed Aircraft Corp.,** California Co., Burbank, Calif., for design and construction of a simulator capable of providing a human subject in a pressure suit with six degrees of operational freedom.

$22,363—**University of St. Thomas,** Houston, for *Biosatellite* project experiment on "effects of zero-graviy on radiation-induced damage in mature reproductive cells."

Mesa Scientific Corp., Inglewood, Calif., for an analysis and evaluation of existing programming management plans and programs for the *Saturn* Operational Ground Computer System at the George C. Marshall Space Flight Center (amount undisclosed).

Cosmodyne Corp., Hawthorne, Calif., for the development of a high-pressure cryogenic pump-vaporizer unit, which will pump and vaporize 50 gpm of either liquid hydrogen or liquid nitrogen to a pressure of 10,000 psi, with an intermittent requirement of 12,000 psi discharge pressure (amount undisclosed).

INDUSTRY

$2,200,000—**Carrier Corp.,** Syracuse, N.Y. from Catalytic Construction Co. to provide a ground-based, environmental control system for *Saturn V*.

$798,000—**General Precision, Inc.,** Kearfott Div., Tarrytown, N.Y., from The Bendix Corp., Detroit, for continued production on a stabilized phase follow-up system for *Talos* missile.

The Te Co., Santa Barbara, Calif., from Utah State University, Salt Lake City, to modify the spectral region on two of four infrared radiometers designed and fabricated under a previous contract (amount undisclosed).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Directorate of R&D Procurement
RTD Systems Engineering Group
Wright-Patterson AFB, Ohio

Negotiations to be conducted with Westinghouse Electric Corp., Dayton, Ohio, for research to establish zero-field operation of masers and to increase the bandwidth of masers. A continuation of contract AF33(657)-10472. RFP not available; for information only.

Procurement Division
Building 4603
Aberdeen Proving Ground, Md.

Study of integrated area correlation techniques for missile guidance. Job RFQ-RD-APG-20-65 due 9/22/64. Requests for RFQ handled on a first-come, first-served basis. Deadline 9/10/64.

U.S. Army Picatinny Arsenal
Dover, New Jersey

Services for feasibility study and design of rocket stabilized rods. RFQ AMC(A)-017-017-65-N63 to be issued 9/18/64. Due 10/18/64. Contact Mr. R. F. Gatewood.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058

Study development and fabrication of trace material generation-rate simulator for use in space-

craft babitability area. RFP BG721-43-5-72P due 9/21/64. Available until 9/7/64 unless supply exhausted earlier. Contact Tony C. Riggan, General Research Procurement Brancb.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058

Negotiations are being conducted with Hamilton Standard Division, United Aircratf Corp., for development of *Apollo* pressure garment assemblies and portable life-support systems. Those interested in subcontracting opportunities should contact the above firm.

Directorate of R&D Procurement
RTD Systems Engineering Group
Wright-Patterson AFB, Obio

Negotiations to be conducted with Bendix Corp., Eclipse-Pioneer Div., Teterboro, N.J., for engineering support for KC-135 flight control system. A continuation of AF 33(715)-1853. For information only; RFP not available.

Directorate of R&D Procurement
RTD Systems Engineering Group
Wright-Patterson AFB, Ohio

Negotiations will be conducted with North American Aviation, Inc., Rocketdyne Div., 6633 Canoga Ave., Canoga Park, Calif., for continuation of an applied researcb program, "Lubrication of journal and thrust bearings with liquid metals." A continuation of Contract AF 33-(657)-10553. RFP not available; for information only.

Directorate of R&D Procurement
RTD Systems Engineering Group
Wright-Patterson AFB, Obio

Negotiations will be conducted with Franklin Institute of the State of Pennsylvania, Philadelphia 3, Pa., for continution of contract AF 33(657)-11234, "Tbe effect of thermo mecbanical variables on the texture and bend ductility of high-purity beryllium sbeet." RFP not available; for information only.

Procurement Division
U.S. Army Electronics Command
Fort Monmouth, N.J. 07703

Award is being made to Airborne Instrument Laboratories, Comac Road, Deer Park, N.Y., for continued research work in the field of satellite communications. RFP not available; for information only.

Headquarters
Space Systems Division
Air Force Systems Command
Los Angeles, Calif.

Award being made to Douglas Aircraft Co., Inc., for launch services for CY 65 at Vandenberg AFB, Calif., RFP not available. Firms interested in subcontracting opportunities should contact the above firm.

U.S. Army Missile Command
Procurement and Production Div.
Redstone Arsenal, Ala.
Attention: AMSMI-IXDA

Selected source procurement for extension of Phase II of contract with Texas Instruments, Inc., 13,500 Nortb Central Expressway, Dallas, Tex., for research and development on infrared detectors. Contract No. DA-01-021-AMC-10434(Z). Those interested in subcontracting opportunities should contact the above firm.

Defense Communications Agency
Code 260
Washington, D.C.

Negotiations are being conducted with IBM, Washington, D.C., for provision of systems study, design and program support in the systems design, programming, installation and modification to an integrated programming data-processing system. Continuation of Contract DA-49-146-XZ-230. RFP not available; for information only.

U.S. Army Missile Command
Redstone Arsenal, Ala.

Precluded award to Raytheon Co., Willow Street, Waltham, Mass., for rebuilding of RF oscillators, 435 each. Delivery 1/31/65. Those interested in subcontracting opportunities sbould contact the above firm.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058

Negotiations will be conducted witb Graham Engineering, P.O. Box 600, Ellington AFB, Texas, for maintenance and operations service for Manned Spacecraft Center. Continuation of NAS 9-1383. RFP not available; for information only. Those interested in subcontracting opportunities should contact tbe above firm.

U.S. Army Missile Command
Redstone Arsenal, Ala.

RFP issued to Sperry Utah Co., Salt Lake City, Utah, for technical and supply publications for the *Sergeant* missile system. Those interested in subcontracting opportunities sbould contact tbe above firm.

reviews

FILAMENT WINDING, ITS DEVELOPMENT, MANUFACTURE, APPLICATIONS AND DESIGN; by D V. Rosoto & C. S. Grove, Jr., John Wiley & Sons, 605 Third Ave., N.Y. 16, N.Y., 360 pp. $15.00

The first major, complete work covering the technology of filament winding in all of its many aspects also includes specifications, test methods and quality control procedures. The authors do not confine themselves only to glass filaments but cover all winding reinforcements.

The book is a valuable reference work as well as a useful primer to the designer about to consider the technique for almost any application. Rosato and Grove detail the many and varied resinous matrices together with applicable sizings. Every known variable is mentioned in the processing and manufacturing aspects.

Factors affecting properties and a thorough treatment of the design criteria are also included. All of the various techniques and approaches are completely referenced. The book lists U.S. firms with a winding ability, all of the many suppliers of both reinforcements and resins and preimpregnators.

Many commercial products can be made through filament winding but the authors gained most of their information on the technique and its components from the heavy national effort in glass-filament-wound pressure vessels.

The authors do an excellent job of documenting the field, and the work is packed with various tables and graphs covering materials, quantities sold, component behavior and the like. Almost every chapter includes the future trends of the sub-area under consideration.

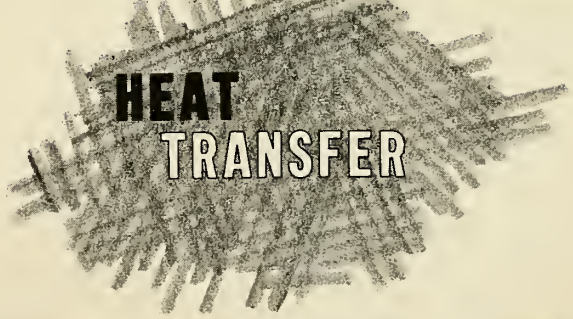
Pratt & Whitney Aircraft is looking for qualified men who want to pit their knowledge and accumulated experience against a variety of complex heat transfer problems. Topics under study vary from advanced gas turbine technology to space application of fuel cells, ramjet and liquid rocket engines.

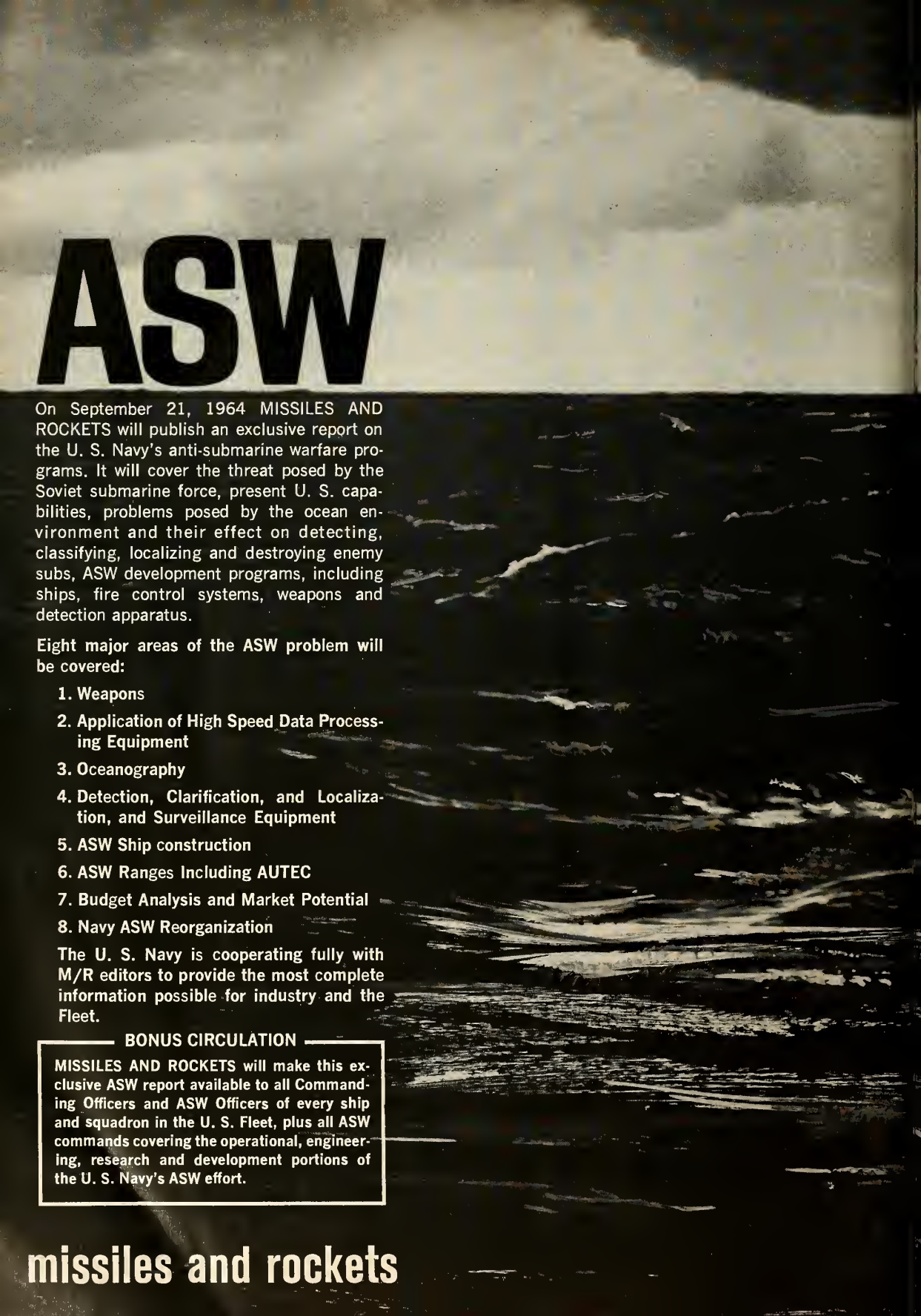
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ASW

On September 21, 1964 MISSILES AND ROCKETS will publish an exclusive report on the U. S. Navy's anti-submarine warfare programs. It will cover the threat posed by the Soviet submarine force, present U. S. capabilities, problems posed by the ocean environment and their effect on detecting, classifying, localizing and destroying enemy subs, ASW development programs, including ships, fire control systems, weapons and detection apparatus.

Eight major areas of the ASW problem will be covered:

1. **Weapons**
2. **Application of High Speed Data Processing Equipment**
3. **Oceanography**
4. **Detection, Clarification, and Localization, and Surveillance Equipment**
5. **ASW Ship construction**
6. **ASW Ranges Including AUTEC**
7. **Budget Analysis and Market Potential**
8. **Navy ASW Reorganization**

The U. S. Navy is cooperating fully with M/R editors to provide the most complete information possible for industry and the Fleet.

BONUS CIRCULATION

MISSILES AND ROCKETS will make this exclusive ASW report available to all Commanding Officers and ASW Officers of every ship and squadron in the U. S. Fleet, plus all ASW commands covering the operational, engineering, research and development portions of the U. S. Navy's ASW effort.

missiles and rockets



Publication Date: September 21, 1964
Closing Date: September 7, 1964

New Product of the Week:

Displacement Detector

Actual amplitudes of vibrations from zero to 0.003 in., at frequencies from dc to 100 kc, can be measured with the Fotonic Sensor available from Mechanical Technology Inc. Accuracies of 10 μ in. are possible in the high frequency range. One model can observe a single μ in. at frequencies less than 100 cps. Models with automatic reflectivity compensation are under development, as are those with extended ranges up to 0.50 in. Multi-channel units are available with the option of remote sensing cartridges on leads of several hundred feet in length. Systems can be designed so that a variety of quick disconnect probe leads can be utilized with one control box enabling the observation of both static or dynamic over wide ranges, with varying accuracy and response.



Circle No. 151 on Subscriber Service Card

Potentiometer

A dual concentric composition element potentiometer has been introduced by Centralab, a division of Globe-Union, Inc.

The unit has a ⅝-in. diameter and is available in both military and commercial versions. It is rated at ¼ watt at 70°C derated to 0 watts at 120°C, per MIL-R-94B. Linear resistance range is 500 ohms to 2.5 megohms; 10% log taper, 5,000 ohms to 2.5 megohms. Electrical rotation is 260 degrees ± 3%.

Circle No. 152 on Subscriber Service Card

Multifunction Test Set

Wiltron Co. is marketing the Model 310 multifunction test set, a phase, amplitude and impedance plotter in one system.

The unit has a specified accuracy of ± 0.01 ± 4% of the reflection coefficient magnitude. Range of gain is 60 db with 0.05-db resolution at any level. Response time is 0.5 millisec., 20 sweeps per second on an oscilloscope. Frequency range is 1 to 12.4 gc in five bands.

Circle No. 153 on Subscriber Service Card

DC Torque Motor

A miniature dc torque motor that develops a peak torque output of 7 oz.-in. has been developed by Inland Motor Corp., subsidiary of Kollmorgen Corp.

The Model 0716 is for use in either closed or open loop servo systems and has end bell construction to minimize radiated noise. Power output is 10 watts at 5,400 rpm. Acceleration is 35,000 rad/sec^2. Electrical and mechanical time constants are at minimum values of 200 microsec. and 24 millisec. respectively.

The unit measures 1 x 1 x 1 1/16 in. and weighs 2.9 oz.

Circle No. 154 on Subscriber Service Card

Time Code Generator

Digital Products Div. of Hyperion Industries, Inc., has available an airborne time code generator, the Model HI-188ABC.

The unit provides a serial time of year code in BCD. Output codes conform to IRIG formats A, B and C, as set forth in IRIG document 104-60. Time of day is set by three decade rotary switches. The unit may be preset to any given time and provisions are made for external time synchronization. Time base frequency is a 100 kc. crystal-controlled oscillator with a guaranteed stability of 1 part in 10^{-8} per day. Operating temperatures are from −55° to 70°C. Altitude capability is 0 to 70,000 ft.

Circle No. 155 on Subscriber Service Card

Subcarrier Discriminator

A tunable FM subcarrier discriminator offering continuous tuning across and beyond IRIG center frequencies and intelligence frequencies is available from the Sarasota Div. of Electro-Mechanical Research, Inc.

The Model 229 demodulates, via phase-locked-loop detection, center frequencies between 300 cps and 300 kc with intelligence frequencies between 3 cps and 30 kc. Deviation-sensitivity stability is ±0.2% for 15 hrs. after a 15-min. warmup. Harmonic distortion is less than 1%; linearity exceeds 0.2%.

Circle No. 156 on Subscriber Service Card

Parity Module

Navigation Computer Corp. is marketing the Model 446 parity module, said to contain all logic needed to generate or check parity for 6 bits of binary data.

The device contains an Exclusive-OR gate which can be used for cascading partity modules or for increasing the capacity of the module by one bit. High speed logic make the module compatible with 300-kc operating rates.

Circle No. 157 on Subscriber Service Card

Semiconductor Strain Gage

A cryogenic semiconductor strain gage featuring low resistance change over a −423° to 600°F operating temperature range has been developed by Micro Systems, Inc.

The Model 11000 has a gage factor of 100 ±10% matched to ±2% in sets of four. Resistance change resulting from temperature is less than 10% per 100% when the element is unbonded. When bonded, change is dependent upon the expansion coefficient. At 78°F unbonded, resistance is 120 ohms ±10% matched to ±2% in sets of four.

Circle No. 158 on Subscriber Service Card

Tachometer

Airpax Electronics, Inc., has available a Type-N solid-state tachometer combined with a magnetic amplifier to provide output currents up to 50 ma dc. Output is directly proportional to low-lever input frequency/rpm information translated by a magnetic pickup which senses magnetic discontinuities in the shafts of rotating equipment. Measurement accuracy is 0.25% or better. Power requirement is 115v RMS, 60 cps.

Circle No. 159 on Subscriber Service Card

LF Receiver

Communication Electronics, Inc., has introduced the Type 302 LF receiver. The unit provides AM and CW reception, covering the 30 to 300-kc

range in three bands: 30 to 60 kc, 60 to 140 kc and 140 to 300 kc. Power requirement is 4 watts.

The device has an intermediate frequency of 455 kc with an IF bandwidth of 2 kc and minimum of 60 db IF rejection. Image rejection is 70 db minimum; audio output is 1v RMS into a 2-kohm load. IF output is 100 mv into 50-ohm load.

Circle No. 160 on Subscriber Service Card

Thin-Film Monitor

Westinghouse Electric Co.'s Scientific Equipment Dept. has developed a thin-film monitor, capable of measuring thickness during deposition at temperatures up to 400°C without water cooling.

The instrument measures changes in mass deposited on a crystal surface by measuring the corresponding change in resonant frequency of the crystal. It can measure evaporated films as thin as 10^{-8} grams per sq. cm. with an accuracy within 1% without correction for other physical properties.

Circle No. 161 on Subscriber Service Card

Mylar Capacitor

A subminiature metalized Mylar capacitor, featuring self-healing without carbonization, has been developed by Texas Capacitor Co.

The Model 31 has a life rating of 125% of rated voltage at 85°C for 250 hours. Temperature range is —55° to 85°C and to 125°C with 50% derating. Capacitance range is 0.01 to 12.0 mfd. Voltage ranges is 200 to 600v dc. Insulation resistance will equal or exceed 30,000 megohm-microfarads at 25°C. Standard tolerance is ±5%.

Circle No. 162 on Subscriber Service Card

Precise Current Source

A new ultra precision current source has been announced by North Hills Electronics. Designed as a ruggedized current source with standards lab performance, the CS-152 is all solid-state. The unit supplies 0-150 ma at



0-25 v dc with a guaranteed long-term (100 hours) stability of better than 10 parts per million. It performs well at low currents.

Features include: high reliability, all-solid-state design, temperature controlled references, window in-line readout, 1 part per million resolution, plus or minus output, low temperature coefficient, programmable, thorough shielding with low ripple, plug-in modules, all silicon, and ease of operation.

Circle No. 163 on Subscriber Service Card

Voltage Transformer

A miniature static-magnetic constant voltage transformer, the Model MCV-1, has been developed by Neshaminy Transformer Corp.

The unit measures $2\frac{7}{16}$ in. long and $1\frac{25}{64}$ in. in diameter. Output is rated at 0.6 volt-amperes at 5v RMS. Output voltage regulation is within ±1% RMS volts ac with input voltage fluctuations from 95 to 130v. Other voltages are available on special order.

Circle No. 164 on Subscriber Service Card

Paper Tape Handler

Digitronics Corp. has developed a bidirectional perforated tape handler capable of speeds up to 1,000 characters per second with 10 ½-in. NAB reels.

The Model 6090 is designed to function with the firm's Model B3000 reader and will handle 5 through 8 level paper tape, paper mylar laminated tape or mylar tape, interchangeably. The device is suitable for standard 19-in. rack mounting and is mounted in two sections, one above and one below the reader.

Circle No. 165 on Subscriber Service Card

Differential Amplifier

An integrated differential amplifier with a common mode rejection of over 100 db at 60 cps is available from Amelco Semiconductor Div. of Teledyne Corp.

The Model D13001 has a temperature stability of better than 3 μv/°C. It features 1 μv/°C tracking without trim pot unaffected from —50° to 100° C. Drift is less than 5 μv/day, referred to input (Rg = 1K), and offset of less than 5 mv, referred to input. Gain is 400 at 1 kc.

Circle No. 166 on Subscriber Service Card

Ultrasonic Cleaner

An ultrasonic system for cleaning precision instruments, electronic components or equipment and other critical parts is available from the Blackstone Corp. This new system consists of a heated and cooled wash/rinse unit, transducer, filtered spray flushing unit and ultrasonic generator.

One chamber in the tank is for ultrasonic immersion and the other is a boiling-sump-and-vapor chamber. The generator provides variable output and timer-control or continuous operation. The solvent spray is circulated through a disposable filter cartridge by a heavy-duty, continuous-rated pump.

Circle No. 167 on Subscriber Service Card

Interdigital Filter

Melabs has developed the Model F-2027 interdigital filter, especially useful for missile and satellite applications. The component weighs 2¼ oz. and has an insertion loss of no more than 1 db over a 8- to 10-gc passband.

The 12-section unit has a rejection



of 50 db minimum at the 7.5- and 10.5-gc points on the skirt. It meets environmental specifications of MIL-E-5400 and measures 3½ x 1 x ½ in.

Circle No. 168 on Subscriber Service Card

Ferrite Isolator

Western Microwave Laboratories has available a line of ferrite circulators and isolators designed to "plug in" stripline subsystems without use of coaxial connectors.

Typical example is the Model ICS-344 isolator, which covers a range of 2.7 to 3.3 gc. Specifications include: isolation, 20 db minimum; insertion loss, 0.5 db maximum; VSWR, 1.2 maximum; termination, ½ watt integral.

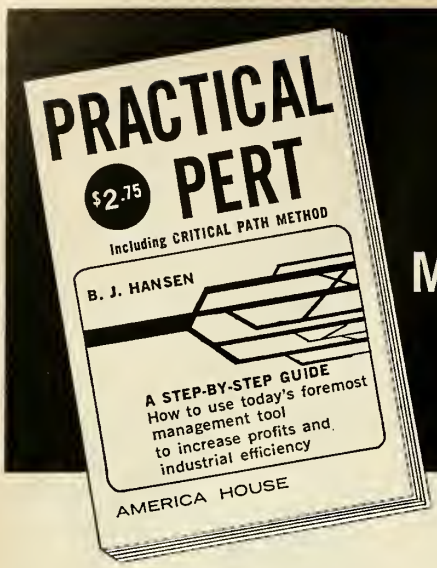
Circle No. 169 on Subscriber Service Card

Stable Xenon Arc Lamp

A new xenon short-arc lamp that combines excellent color-matching qualities with extreme arc stability over a wide range of power inputs has been introduced by PEK Labs, Inc.

PEK X-500 provides a stable arc and luminous output proportional to power input from 250 to 600 watts. Using an arc size of 0.080 x 0.150 in., the new lamp develops an average brightness of 35,000 candles per sq. centimeter with a luminous efficiency of 25 lumens per watt. The spectral characteristics of the lamp closely approximate natural sunlight. The average life of the X-500 is in excess of 1500 hours.

Circle No. 170 on Subscriber Service Card



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Universal Electromanometer

Consolidated Electrodynamics Corp. has introduced a low-price universal electromanometer.

The electromanometer consists of a servo amplifier and a precision pressure balance. Additional components include precision pressure balances for wide pressure range capability, a multi-channel adapter for economical amplifier use, and three rack-mount adapters for a choice of installation modes.

The standard Type 4-336 precision pressure balance is available in ranges of ± 5 lbs. psid, ± 15 psid, and ± 60 psid, and in 5 lbs. psia, 15 psia, and 60 psia ranges.

Circle No. 182 on Subscriber Service Card

Crystal Controlled Oscillator

Monitor Products' Model 675 Crystal Controlled Oscillator is a miniature solid-state unit available at any fixed frequency between 75 kc and 3 mc. This high environment oscillator measures 1 x 1 x 1 in. and can be PC board-mounted. Output is 10v p-p into a 5K load, square wave. Operating temperature range is available to 110°C.

Circle No. 171 on Subscriber Service Card

Ceramic Capacitor

New subminiature sophisticated ceramic capacitor offers a 0.1 to a 2.5 uf capacitance with a plus or minus 20% tolerance and maximum capacitance change of plus or minus 15% over a temperature range of −55°C to plus or minus 125°C. Voltage rating is 100 WVDC with no derating to 125°C; dissipation factor less than 2½% at 25°C. Envelope is epoxy dipped for maximum environmental protection and was developed by Nytronics, Inc.

Circle No. 172 on Subscriber Service Card

GaAs Injection Laser

Philco Corp. has introduced a gallium-arsenide injection laser, the GAL-450, which features a miniature dewar that cools the device to the temperature of liquid nitrogen (77°K) without causing distortion to the output beam. The dewar method eliminates output beam distortion caused by the nitrogen bubbles inherent in the usual laser-cooling technique.

The laser contains a diffused p-n junction gallium-arsenide optical diode that emits light in the near infrared region of the spectrum when forward-biased.

The laser converts current directly to light, avoiding the need for a flash-tube, and consequently not needing auxiliary equipment to drive it.

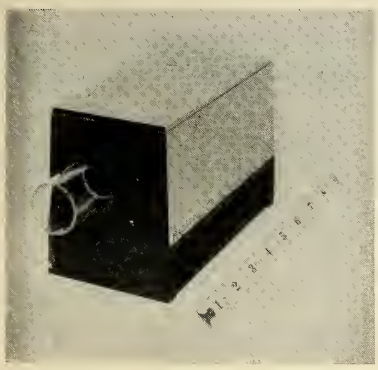
The average power dissipation is

100 mw; maximum peak current, 2-microsec. pulses 60 pps, is 80 amperes; typical current at lasing threshold is 20 amperes; wavelength at threshold is 8,550 Å; linewidth at threshold is 10 Å; and peak power output at 40 amperes is 2 watts.

Circle No. 173 on Subscriber Service Card

Liquid Calorimeter

A liquid calorimeter that reportedly measures the energy output of a laser beam with three times the absolute accuracy of existing devices has been developed by Korad Corp. The new in-



strument is accurate to within 3% of absolute value.

The calorimeter operates on the principle of the complete conversion of light energy into heat through the medium of the liquid cell. The change in temperature is detected by a sensitive high-output thermopile. The instrument weighs three and one-half pounds, and is available in three models, the K-J2, K-J3 and K-J4. The models vary only in aperture size, ½-, 1- and 2-in., and energy ranges, 0.01-100, 0.1-500 and 1-10,000 joules, respectively.

Circle No. 174 on Subscriber Service Card

Miniature Transformer

Torwico Electronics has announced the extension of the Standard TINY-MAX 400 Cycle Miniature Power Transformer line—now available with ratings of 1.5va through 250va. The toroidal transformers have a low temperature rise, low regulation and phase shift, negligible radiated field, and comply with MIL-T-27, Grade 4, Class S specifications.

Circle No. 175 on Subscriber Service Card

Encoding System

A newly developed encoding system has the capabilities of measuring and digitally encoding angles with accuracies as high as one part in one million. The system consists of a precision dual-speed magnetic transducer (DSMT) and a display counter, and meets the most exacting requirements for a variety of applications ranging from large antenna installations to small components in space vehicles.

The DSMT transduces shaft angles into analog a-c signals; the simple solid-state electronics of the system converts the angles into the phase time domain where clock pulses are counted to give a digital measurement of the angle. The system features zero velocity error. Interrogation is possible at any instant. It is completely gearless, making the problem of backlash, wear, and alignment non-existent. The system is a design and development of the Bendix Corp.

Circle No. 176 on Subscriber Service Card

Impact Testing System

Fabric Research Laboratories, Inc. has developed a new fabric research impact testing system that makes impact testing possible at both elevated or subambient temperatures.

The system, Frits-V, is pneumatically operated using nitrogen or helium gas and is capable of straining materials at speeds ranging from 30 to 100 fps. (or maximum of 72,000 in. per min.). It is used for testing paper, plastics, metals, webbings, tire cords and other materials whose service involves impact.

Circle No. 177 on Subscriber Service Card

Voltage Variable Capacitors

Eastron Corp. has available silicon voltage variable capacitors with a Q of 200 over a capacitance range of 7 pf to 33 pf. Guaranteed low leakage and a higher tuning ratio are also featured. They are useful in the 400 mc to 1,400 mc region for tuned circuits, harmonic generators and frequency modulation, and are available in 5%, 10% and 20% tolerances.

Circle No. 178 on Subscriber Service Card

Transistorized Transmitters

Norden Div. of United Aircraft Corp has introduced three all-transistorized transmitters in the 215 to 260-mc frequency range. The Models T-1125, T-2125, and TF-5 are reduced in size, weight and power. The units are designed for operation in manned aircraft, guided missiles, satellites and space vehicles.

The T-1125 is a crystal-stabilized true FM transmitter providing 2 watts nominal output. Its input impedance is 100 k ohms shunted by 5 pf. Power requirements are 28v dc ± 10% at 550 ma. It measures 3¼ x 2¼ x 2 in. and weighs less than 13 oz. T-2125 is crystal controlled, phase modulated and has a frequency stability of ± 0.005%. Power output is 2 watts nominal, while power requirements are 28v dc ± 10% at 550 ma. It measures 3.5 x 2.5 x 1.5 in. and weighs 12 oz. Model TF-5 is a stable, linear, accurate and rugged true FM transmitter with unique modulation circuitry having a frequency response down to dc, and linearity better than plus or minus 0.5%. Power requirements are 28v dc at 1.0 amps nominal. It measures 4.858 x 2.906 x 1.707 in. and weighs approximately 20 oz.

Circle No. 179 on Subscriber Service Card

Thumbwheel Switch

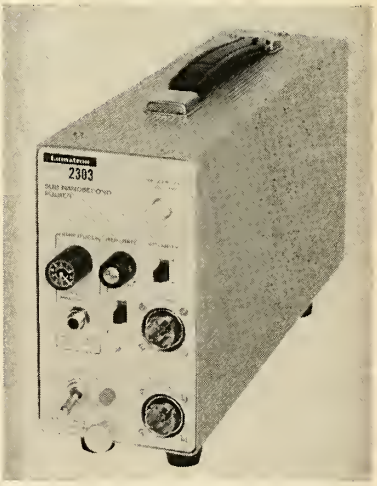
Digitran Co. has introduced the Miniswitch, a small sealed thumbwheel switch made for industrial and military applications. It converts directly from decimal dial setting to coded electrical output. It is modular in design, with each module requiring a panel output of only 0.96″ high x 0.5″ wide. All switch elements are sealed in a separate chamber within the switch and are protected from severe environments (sand, dust, explosive atmosphere). No portion of the printed circuit is exposed to possible contaminants or high humidity.

Circle No. 180 on Subscriber Service Card

Sub-Nanosecond Pulser

A new sub-nanosecond pulser providing two amps of current into 50 ohms with less than 0.3 nanosec. rise time is available from General Applied Science Laboratories, Inc.

The pulser employs a mercury-wetted, long-life switch in a specially



designed coaxial cavity. Its comparatively high repetition rate provides a steady display on sampling oscilloscopes.

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names in the news


SMITH


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MITCHELL

Charles B. Smith: Elected to the board of directors of Electronic Speciality Co., Los Angeles. He is an associate of Laurance S. Rockefeller and is also a director of several other companies in the scientific and technical fields.

Leslie E. Simon (Maj. Gen. USA-Ret.): Elected to the board of directors at Electro-Tec Corp., Ormond Beach, Fla. He was formerly vice president and director of research of The Carborundum Co.

B. J. Hansen: Appointed vice president-systems division of John I. Thompson & Co., Washington, D.C., a consulting engineering organization. He was formerly vice president of Computer Dynamics Corp., and has extensive experience in the field of computers and automation.

Elliot Mitchell: Appointed manager of Eastern operations for United Technology Center, Sunnyvale, Calif. He was formerly with NASA and the Navy. His previous experience is in propulsion research and development.

James H. Wakelin, Jr.: To head the Technical Advisory Board of Ryan Aeronautical Co., San Diego. He has recently retired as Assistant Secretary of the Navy for Research and Development.

Herbert Trotter, Jr.: Named to the Joint Technical Advisory Committee of the Inst. of Electrical and Electronics Engineers, Inc., and the Electronic Industries Assn. He is chairman of General Telephone & Electronics Labs, Inc., New York City.

Philip R. Mallory: Resigned as chairman of the Board of Directors of P. R. Mallory & Co., Inc., after 48 years of service. He was elected honorary chairman and will remain on the board as a director. Succeeding him as chairman will be **C. Harvy Bradley.**

Edward T. Kirkpatrick: Appointed Dean of the College of Applied Science at Rochester Institute of Technology, Rochester, N.Y.

Merrill W. Lowry: Joined the staff of DeMornay-Bonardi, Pasadena, Calif., as microwave engineer. He will specialize in design of new components and in the development of ultra-microwave systems for analytical applications.

John D. Temoyan: Appointed midwestern regional manager, Philco Corporate Marketing, Philco Corp.'s TechRep Div., Dayton, Ohio.

William H. Jones: Appointed manager of the microelectronic sciences section of the Data Systems Div. of Litton Industries, Beverly Hills, Calif. He was formerly a senior physicist in the microelectronic engineering department.

Howard E. Brewer: Named chief engineer of California Computer Products, Inc. Anaheim, Calif. He was previously with North American Aviation, Inc.

George L. Buc: Named manager of Physics and Optics Research for Farrington Electronics, Inc., New York City. He will be responsible for research in optical techniques and their application to present and future products.

Earl E. Worner: Named president of the newly formed Worthington Controls Co., Norwood, Mass. Worthington Controls is a division of Worthington Corp., Los Angeles.

Wallace Osgood Fenn: Recipient of the Daniel and Florence Guggenheim International Astronautics Award for 1964. He is with the Dept. of Physiology at the Univ. of Rochester School of Medicine and Dentistry. His studies have mainly been in respiratory problems, muscle research, and nerves. The award is offered annually by the International Academy of Astronautics and carries with it a prize of $1,000.

Joseph Mandelkorn: Received the NASA Contributions Award and $5,000 recently for the development of improved radiation resistant solar cells. He is with Lewis Research Center, Cleveland, Ohio.

Robert Lawrence III: Named manager for the Aerospace/Industrial Div. of Heinicke Instruments Co., Hollywood, Fla.

Horace C. Knerr: Founder and chairman of the board of Metlab Co., Philadelphia, was selected to receive the William Hunt Eisenman Award of the American Society for Metals. He will receive the award at the ASM Metals/Materials Exposition and Congress, Oct. 19-23 in Philadelphia. The award is presented for engineering achievement.

—when and where

AUGUST

Electric Propulsion Conference, AIAA, Bellevue-Stratford Hotel, Philadelphia, Aug. 31-Sept. 2.

45th Summer Meeting, sponsored by the Mathematical Association of America and the American Mathematical Society, Univ. of Massachusetts, Amherst, Aug. 31-Sept. 2.

Third Geneva Conference on the Peaceful Uses of Atomic Energy, sponsored by the United Nations, Geneva, Switzerland, Aug. 31-Sept. 11.

SEPTEMBER

Third Biennial Aerospace Power Systems Conference, AIAA, Bellevue-Stratford Hotel, Philadelphia, Sept. 1-4.

Meeting of the International Commission for Optics, Tokyo and Kyoto, Japan, Sept. 1-8.

Chemistry of Matrices used in Filament Winding Symposium, 148th National Meeting of the American Chemical Society, Sheraton-Chicago Hotel, Chicago, Sept 3-4.

Symposium on Spacesuits and Human Performance, sponsored hy the Society of Engineering Psychologists, American Psychological Association Annual Convention, Biltmore Hotel, Los Angeles, Sept. 6.

International Conference on Magnetism, sponsored by the International Union of Pure and Applied Physics and the British National Committee for Physics, Nottingham, England, Sept. 7-11.

International Conference on Microwaves, Circuit Theory and Information Theory, IECE of Japan/IEEE, Tokyo, Japan, Sept. 7-11.

Fifteenth Congress, International Astronautical Federation, sponsored by the IAF, Warsaw, Poland, Sept. 7-12.

British Aerospace Companies' Flying Display and Exhibition, Farnborough, Hampshire, England, Sept. 7-13.

National Power Conference, IEEE and ASME, Mayo Hotel, Tulsa, Okla., Sept. 9-11.

Twelfth Annual Engineering Management Conference, sponsored by the IEEE, ASME, AIIE, ASCE, and others, Pick-Carter Hotel, Cleveland, Sept. 9-11.

Advanced Incentive Contracting, sponsored hy the National Defense Education Institute, Boston, Sept. 9-11.

54th National Meeting of the American Institute of Chemical Engineers, Flamingo Hotel, Las Vegas, Nev., Sept. 13-16.

Eighth National Convention on Military Electronics, sponsored by the IEEE and the Military, Washington Hilton Hotel, Washington, D.C., Sept. 14-16.

Symposium on Mass Spectrometry sponsored hy the Group for the Advancement of Spectrographic Methods, Paris, Sept. 14-18.

World Conference on Radio Meteorology sponsored by the American Meteorological Society, National Bureau of Standards, Boulder, Colo., Sept. 14-18.

Techniques of Value Engineering for Defense and Space Contractors, sponsored by the National Defense Education Institute, Washington, D.C., Sept. 14-18.

First International Cellular Plastics Conference sponsored hy the Cellular Plastics Div. of the Society of the Plastics Industry, Inc., Barbizon Plaza Hotel, New York City, Sept. 14-18.

"Modern Engineering Applications of Computers" a course sponsored by Control Technology, Inc., Edgewater Inn, Long Beach, Calif., Sept. 14-18.

49th Norelco X-Ray Analytical School sponsored hy Philips Electronic Instruments, Sir Francis Drake Hotel, San Francisco, Sept. 14-18.

Third European Symposium on Chemical Reaction Engineering, Amsterdam, Netherlands, Sept. 15-17.

Electronics Division Fall Meeting sponsored by the American Chemical Society, Sheraton Hotel, Philadelphia, Sept. 15-18.

Value Engineering Conference, sponsored hy the North Alahama Chapter AIIE, Officer's Club, Redstone Arsenal, Sept. 16.

American Ceramic Soicety Electronics Division Fall Meeting, Sheraton Hotel, Philadelphia, Sept. 16-18.

Zonal Centrifuge Conference, sponsored by the Oak Ridge National Laboratory, ORNL, Oak Ridge, Tenn., Sept. 16-18.

International Conference on Diffusion in Body-Centered Cuhic Materials, sponsored hy the Oak Ridge National Laboratory and the Oak Ridge Chapter of the American Society for Metals, Mountain View Hotel, Gatlinburg, Tenn., Sept. 16-18.

Annual Engineering Management Conference, sponsored hy AIIE, IEEE, ASME, and ASCE, Pick-Carter, Hotel, Cleveland, Sept. 17-18.

Southeastern Regional Conference, sponsored hy the Society of American Military Engineers, Arnold Engineering Development Center, Tullahoma, Tenn., Sept. 17-19.

54th National Meeting of the American Institute of Chemical Engineers, Flamingo Hotel, Las Vegas, Sept. 20-23.

Ceramic-Metal Systems Division Meeting, sponsored hy the American Chemical Society, French Lick-Sheraton Hotel, French Lick, Ind., Sept. 20-23.

Fourth Annual National Conference on Environmental Effects on Aircraft and Propulsion Systems, sponsored hy U.S. Naval Air Turhine Test Station, Nassau Inn, Princeton, N.J., Sept. 21-23.

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That Visceral Feeling

THE PROTRACTED DEATH of the *Mobile Medium-Range Ballistic Missile (MMRBM)* program is of significant interest to the industry's market planners.

The project has been limping along on an on-again, off-again basis for several years and even now a final abortive attempt is being made to salvage it. *MMRBM's* demise, however, is assured—despite a small Administration worry that its cancellation will lend further ammunition to the political opposition.

There is little question of the technical feasibility of *MMRBM*. It is, and has been for a long time, well within the state of the art. There is no doubt that it is an attractive package, offering as it does the advantages of land and sea mobility as well as the potential of a hard-site, relatively low-cost missile which could be air-transportable.

But as the Beatniks say, who needs it?

It has been apparent from the advent of the McNamara regime in the Pentagon that *MMRBM* has had no place in the current scheme of U.S. defenses. The fact that the Soviet Union has an estimated 750 non-mobile MRBM's plus a smaller number of IRBM's has little effect on U.S. requirements for a similar missile.

The need for an *MMRBM*, if it could in fact be spelled out, lies in the area of NATO requirements. NATO commanders have been the most active in pressing for it. The feeling is that *MMRBM* would give European nations a counter to the Soviet threat.

Despite this, there has been relatively little enthusiasm in Europe for the missile. For one thing, most Europeans are quite content to have the deterrents to Soviet power somewhere besides on their own soil. Deployment of *MMRBM* would change that.

But even upon a firm requirement for such a missile still would not guarantee a future market for a U.S.-built weapon. At the time the *MMRBM* program was initiated, there might have been some question about the ability of European firms to build such a weapon. No such question now exists and there is little doubt that European nations today would prefer to build their own missile, rather than accept a U.S. weapon with its accompanying disadvantage of U.S. warhead control. France, in fact, already is engaged in such development.

There are more than a few grounds for suspecting that the *MMRBM* program has, in fact, been used as a political ploy to discourage European firms from undertaking development of their own missile. As long as the prospect existed that a U.S. *MMRBM* might go into production, the prospective market for a European manufacturer was unattractive.

For as long as that situation existed, the U.S. was succeeding in one of its most cherished hopes—retaining the nuclear missile power of the West in its own hands. *MMRBM*, even as a proposal, thus already was an effective deterrent—not to the Soviets, but to European entry into the nuclear club.

Gen. de Gaulle's determination to build an independent French national force has shattered that gambit. *MMRBM's* usefulness as a political deterrent, as could be foreseen, has ended.

Death of the program, therefore, is hardly surprising.

THESE CIRCUMSTANCES may explain the strange conduct of the Dept. of Defense in its lukewarm support of *MMRBM* on the Hill before Congress. Since the game with the Europeans hardly could be explained openly, DOD was forced to resort to such odd tactics that Rep. Daniel Flood (D-Pa.) described the attempt to pin DOD down on the program as similar to trying to pick up a handful of quicksilver from a metal table.

Some of the dialogue between Rep. Flood and Defense Research and Engineering Director Dr. Harold Brown is enlightening:

MR. FLOOD: I have a visceral sensation that Mr. McNamara and his minions have not rushed out to embrace the *MMRBM* down through the current years, but they are merely putting up with it, that there was no particular enthusiasm, and it was one of these old adages of the difference between "Keep off the grass" and "Keep off the grass positively."

MR. BROWN: Mr. McNamara, I believe, has consistently supported this in all his appearances before the Congress. I think he has a visceral feeling that this is a very important program . . . he does support it. He wants to go forward. It can only go forward with sufficient funds . . . If, when we go back for permission to reprogram back up to $110 million, we do not get that permission from the congressional committees, I think Mr. McNamara will cancel the full-scale development. I think he would be willing to keep the stellar inertial guidance system going because that could be applied to other programs at a later date.

Mr. Flood, obviously surprised at the thought of Mr. McNamara making program decisions in the vicinity of his viscera, then went into the attitude of Deputy Defense Secretary Gilpatric, who had testified the previous year in McNamara's absence.

MR. FLOOD: When the House refused this money last year, Mr. McNamara, under the procedure, had to appear before the Senate. Gilpatric was his pigeon, his mouthpiece . . . Accoutred with all of his prestige and power of his position, he spoke for the Department, hence, McNamara. He said in effect that he could live with the cut of a hundred million dollars —and proceeded to live with it. The point I make is that kind of attitude, that kind of statement under the circumstances was precisely what I meant a few minutes ago, that they were not at Defense level enamored with the *MMRBM*. . . .

Mr. Flood suggested that this attitude—which he summed up as "You are not dying for Rutgers on *MMRBM*"—was fatal to those who favored the program.

Just what his reaction will be to DOD's attempt to pin the blame for the death of the program on Congress is imaginable if not printable.

Meanwhile, the visceral feeling persists that *MMRBM* already has served the extent of its usefulness as a deterrent and that is why it is expendable.

William J. Coughlin

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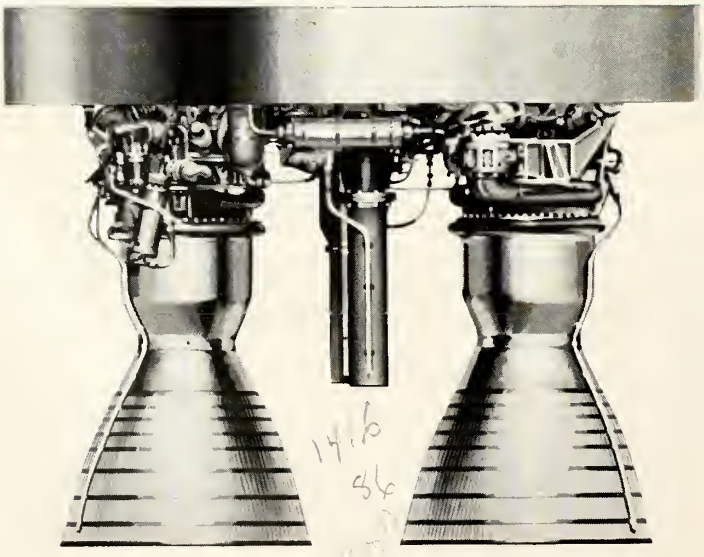
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